Attachment B

Response to Resource Report 3, Question 13

# Baseline Entrainment Characterization Report

# Aguirre Offshore Gasport Project

# Baseline Entrainment Characterization Report

**(Version 4, Finalized 2012 Data)**

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| CEQ | Council on Environmental Quality |
| CFMC | Caribbean Fishery Management Council |
| Commonwealth | Commonwealth of Puerto Rico |
| CSP | Continuous Sampling Plan |
| CWA | Clean Water Act |
| CWIS | Cooling Water Intake Structure |
| EFH | essential fish habitat |
| EIS | Environmental Impact Statement |
| EPA | U.S. Environmental Protection Agency |
| FERC | Federal Energy Regulatory Commission |
| FOM | fine organic matter |
| FSRU | floating storage and regasification unit |
| ft. | foot/feet |
| fps | Feet per second |
| GPS | Global Positioning System |
| JBNERR | Jobos Bay National Estuarine Research Reserve |
| LNG | liquefied natural gas |
| LNGC | liquefied natural gas carrier |
| $m^3$ | cubic meter |
| m | meter/meters |
| mm | millimeters |
| MGD | million gallons per day |
| NEPA | National Environmental Policy Act |
| NMFS | National Marine Fisheries Service |
| NPDES | National Pollutant Discharge Elimination System |
| Project | Aguirre Offshore GasPort Project |
| QA | quality assurance |
| QC | quality control |
| UPR | University of Puerto Rico |

# 1. INTRODUCTION

In support of the Aguirre Offshore GasPort Project (Project), Tetra Tech conducted towed ichthyoplankton net sampling offshore of Boca del Infierno, near Guayama, and about 1 mile outside of the Jobos Bay National Estuarine Research Reserve (JBNERR) along the southern shore of the Commonwealth of Puerto Rico in Commonwealth waters. Jobos Bay and surrounding marine ecosystems contain a mosaic of habitats including coral reef, hardbottom, seagrass, and mangrove communities. Excelerate Energy is seeking authority to construct and operate the project via an Order Granting Authorization under Section 3 of the Natural Gas Act. The Federal Energy Regulatory Commission (FERC) is the lead agency in preparing an Environmental Impact Statement (EIS) in compliance with the Council on Environmental Quality (CEQ) regulations for implementing the National Environmental Policy Act (NEPA), and the FERC's implementing regulations under Chapter I, Title 18, Code of Federal Regulations, Part 380. As the federal lead agency, the FERC must also comply with Section 7 of the Endangered Species Act of 1973, and with Section 106 of the National Historic Preservation Act.

This study is aimed at producing the requisite preliminary data needed to calculate annual entrainment of organisms (i.e., finfish and shellfish) through the cooling water intakes of the vessels associated with the GasPort to satisfy 316(b) requirements of the pending National Pollutant Discharge Elimination System (NPDES) permit under the Clean Water Act (CWA). For purposes of this entrainment characterization, all fish and shellfish eggs and larvae were identified to the lowest practical taxonomic level (typically family), and the term "shellfish" refers to lobster, shrimp, crab, and mollusks. The data collected during this study will also support the essential fish habitat (EFH) assessment, as part of a separate submittal for this proposed facility.

This report describes the preliminary results of a single ichthyoplankton sampling event and a single ichthyofauna observation event at the proposed floating storage and regasification unit (FSRU vessel) and liquefied natural gas carrier (LNGC vessel) invicinty of the  OffShore Gasport location. This sampling program has been initiated as a first step towards satisfying anticipated data requirements necessary to characterize the existing levels of entrainment in accordance with the 316(b) regulations that will be enforced at this facility by the forthcoming National Pollutant Discharge Elimination System (NPDES) permit to be issued by the United States (U.S.) Environmental Protection Agency (EPA) Region 2. The purpose of this monitoring is to evaluate the occurrence and densities of species entrained in the cooling water intake of the FSRU and LNGC vessels.

# 2. COOLING WATER INTAKE SPECIFICATIONS

The normal water use requirements of the FSRU vessel is approximately 55.8 million gallons per day (MGD) of seawater intake, operated continuously and year-round, at a rate of approximately 0.45 feet per second (fps) (Table 1). Of this volume, approximately 54 million gallons are used to support machinery cooling and the operation of the vessel's safety water curtain after which it is discharged. The remaining 2 MGD are retained as ballast water and water to support crew needs (e.g., sanitary needs and potable water). The water use of the LNGC vessel is variable, depending on the actual vessel used for delivery (unknown at this time). However, the maximum intake volume for vessels of this class is 81.6 MGD during offloading operations that include 88 hrs of moorage at the berthing location. For the purposes of this study, the maximum intake volumes used to estimate entrainment for FSRU and LNGC vessels are 55.8 MGD and 81.6 MGD, respectively.

**Table 1: Summary of Standard FSRU Water Use Intakes and Discharges**

| FSRU Vessels | Water Use | Maximum Intake Pump Capacity (m$^3$/hr)* | FSRU Seawater Intake (MGD)† | FSRU Seawater Discharge (MGD)‡ |
|---|---|---|---|---|
| FSRU | Main condenser cooling system | 7,400 | 47.0 | 47.0 |
| | Auxiliary seawater cooling system | 935 | 6.0 | 6.0 |
| | Safety water curtain | 90 | 0.6 | 0.6 |
| | Ballast water | 295 | 1.9 | 1.9** |
| | Freshwater generator | 48 | 0.3 | 0.27 |
| | | **Total** | **55.8** | **55.77** |
| LNGC | Main condenser cooling system | Variable; depending on actual vessel used | | |
| | Auxiliary seawater cooling system | | | |
| | Safety water curtain | | | |
| | Ballast water | | | |
| | Freshwater generator | | | |
| | | **Total** | **81.6 maximum while berthed** | |

*Based on standard operation of an Excelerate Energy FSRU (Energy Bridge Regasification Vessels).

**Variable (±1.9)depending on ship needs, sea conditions and operation

† m$^3$/hr = cubic meters per hour

‡MGD = million gallons per day (one gallon = 0.0037854118 m$^3$)

Since water withdrawal rates will be < 0.5 fps, both the FSRU and LNGC vessels are expected to meet the 316(b) performance standards for impingement of larger juveniles and adults, therefore impingement will not be discussed further. Section 316(b) also requires the assessment of impacts from the entrainment of early life stages (eggs, larvae, juveniles) of fish and shellfish by the cooling water intake structure (CWIS) for the vessel. The FSRU vessel and LNGC vessel withdraw water from lower and higher sea chests located at 7 m and 11 m below the surface; therefore, potential entrainment impacts would be concentrated at those depths in the mid-water column.

# 3. METHODS

This section describes the equipment and methods for implementation of the field activities in support of this entrainment characterization report. The survey methodology, as described fully in the Work Plan (Tetra Tech, 2012a), has been designed for accuracy, reproducibility, and for full capture of the representative fish and shellfish groups that may be susceptible to entrainment through the cooling water intake of the FSRU and supporting LNGCs.

## 3.1 Survey Area

The survey area includes the planned location of the offshore FSRU berthing platform. The pipeline route extending from the Central Aguirre Power Plant through Jobos Bay and offshore to the Offshore Gasport was not included because potential entrainment impacts would only occur within the proposed mooring area where the FSRU and LNGC vessels will be berthed. The ichthyoplankton survey was conducted using towed net transect methods. Figure 1 presents the offshore survey area and the proposed/actual survey transect lines.

Four sampling transects were sampled during a single daytime event and a single nighttime event on 23 May 2012. The sampling effort outlined in Table 2 was designed to capture the diel variation in ichthyoplankton abundance during typical conditions in the FSRU during May. Additional data would be needed to characterize the seasonal differences in entrainment densities/impact on an annual basis. If seasonal variation in ichthyoplankton densities are quantified, it may be possible to mitigate potential entrainment impacts, by accounting for that within the proposed liquefied natural gas (LNG) delivery schedule. When completed, the FSRU vessel would be in continuous operation (year-round) and LNGC vessel deliveries would occur at a frequency of during 50 discrete shiipments annually over durtions of 88-hr periods.

**Table 2: Timeframe and Number of Events and Number of Samples Proposed**

| Ichthyoplankton Sampling | |
|---|---|
| **Timeframe** | 23 May 2012 (day and night samples) |
| **Offshore terminal location** | Proposed berthing areas |
| **Number of events** | 1 (spring) |
| **Number of samples** | 16 total samples per event<br>• Four towed transects (covering berthing area; 2 tows per transect, day and night samples) |
| **Additional qualitative samples** | A single 3-minute surface tow was also conducted using a 64-micron mesh |
| **Collection method** | Oblique towed samples |

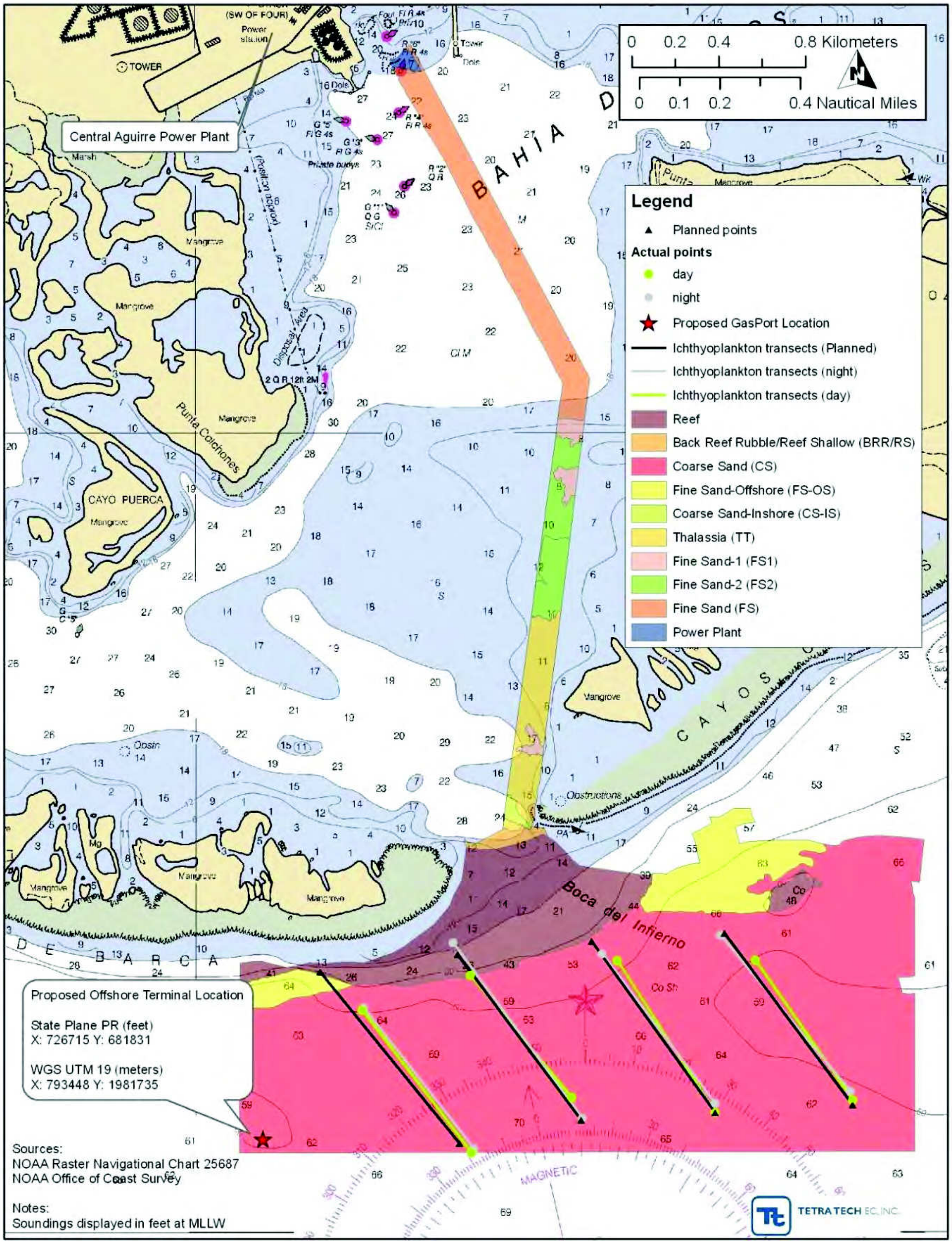


**Figure 1: Offshore Ichthyoplankton Sampling Transects within the FSRU Project Area. Habitat and Substrate Types are Fully Described in Tetra Tech (2012b).**

### 3.2 Baseline Information Needs and Data Gap Analysis

Tetra Tech conducted preliminary background research to obtain existing information about the project area and associated fish populations needed to develop this characterization. Fish data does exist for Jobos Bay including the sampling data and 316(b) demonstration for the Aguirre Power Plant complex and routine monitoring within the NERR. However, data for the waters immediately offshore from the bay remain limited. Several fish and shellfish groups have EFH within the project area, as designated by the Caribbean Fishery Management Council (CFMC). Several species are also considered "species of concern" by NMFS, or protected under the ESA. Results of the review are summarized in Appendix I of this report.

These information sources were used to develop a preliminary list of representative species for the entrainment characterization for the FSRU vessel and LNGC vessel. Fish species occurrences, spawning season, location in the water column, egg size, fecundity, and other reproductive factors were evaluated to identify a species' potential for entrainment within the project area. These data will also support the EFH Assessment for this project (not included in this report).

### 3.3 Ichthyofauna Observations

Observational data of the fish species present in the survey area were collected by scientific divers experienced in fish identification during the benthic habitat dive survey (see Tetra Tech 2012b). Qualitative ichthyofauna data were collected using diver assisted non-point visual census method designed to contribute to a comprehensive species list for the project area. During the benthic surveys, scientific divers recorded all fish species observed within each benthic survey station and while swimming throughout the study area and pipeline route. Divers used a separate reef fish data sheet to record only presence data of species with no abundance estimates. Dive time, depth, temperature and other environmental information were also recorded on each data sheet. Divers retained the data sheet for all dives conducted within a specific habitat type. Data sheets from all divers within a given survey area were combined following field activities and processed as a single habitat only survey, yielding the total number of fish species for each distinct habitat type (i.e., seagrass, mud, hard bottom, reef, etc.).

### 3.4 Ichthyoplankton Sampling

Tetra Tech teamed with the University of Puerto Rico (UPR) Mayaguez researcher Dr. Jorge Garcia to conduct the ichthyoplankton survey and laboratory identifications. Sampling was conducted aboard the 42 foot (ft.) *R/V Sultana*. Tetra Tech provided technical oversight and quality control during field sampling and subsequent laboratory analysis. For the purposes of this report, the term ichthyoplankton refers to both fish and shellfish planktonic lifestages.

Ichthyoplankton was sampled from all depths across four transects using a 0.6 m-diameter bongo net with 300-micron mesh towed from the survey vessel. The bongo net consisted of dual 0.6 m diameter plankton nets. A depresser weight was fixed to the bongo frame to add stability to the net at varying depths. Mechanical flowmeters (*General Oceanics* Model-2030R) were mounted inside each of the nets to provide volumetric data. A collection efficiency of greater than 90 percent is typically desired and was calculated prior to the sampling event by towing the bongo net along a remesured transect with both flowmeters and only one of the plankton nets attached, providing a ratio of the total flow measured both inside and outside of the net while under tow. This efficiency value was calculated for each sample event by dividing the total flow measured by the inside flowmeter by the total flow measured by the outside flowmeter in the frame without the cod end net.

All ichthyoplankton samples were collected at tow-speeds between 2 and 3 knots. At this speed, the duration of the 100 $m^3$ (minimum) target sample volume was estimated to be approximately 10 minutes. Tows were extended an additional 2 minutes to ensure the minimum sample volume was exceeded. With the observed high filtering efficiencies approaching 100 percent, and slow tow speeds, there is no reason to suspect that any clogging of the net mesh or extrusion of organisms through the mesh occurred with this ichthyoplankton sampling method.

Oblique tows were conducted at all four transect locations. Daytime samples were collected between 1200 and 1630 hours and nighttime samples were collected between 2100 and 2330 hours. As the tow vessel moved along the oblique tow transect, the net covered all depth zones, as identified from the vessel's onboard depth finder. Towing depth was controlled by monitoring the angle of the tow cable in relation to the length of the deployed tow cable. The tow continued along the transect until the appropriate tow duration was achieved. The combination of the volume of water passing through the net and the number of organisms collected determined the sample density of the ichthyoplankton in the water column.

During the field effort, a field log book was kept for all ichthyoplankton sampling activities. Data forms generated in the field or by the laboratory were digitized. Detailed steps for conducting oblique bongo net sampling were described in the Work Plan. See Figure 1 for a map showing the sampling transects. The start and end points of each transect were recorded using an onboard Global Positioning System (GPS), the *Garmin GPSMAP 4212*.

### 3.5 Ichthyoplankton Analysis

After each tow was completed, the net was retrieved, backwashed, and rinsed with seawater on the deck. After rinsing the cod end of each net (Figure 2), samples were transferred to a jar and preserved with 10 percent buffered formalin and stored in a container on-site. Preserved samples were transferred to the UPR ichthyoplankton laboratory at Isla Magueyez. All samples were processed in accordance with the quality assurance and quality control specifications that have been described in the Work Plan for this project. A minimum subsampling criterion of 200 eggs or 100 larvae was used to invoke sub-sampling procedures. When that criterion was met, appropriate splitting procedures were used in accordance with the Work Plan.

The collected fish and shellfish eggs and larvae were hand-picked and sorted from each net sample following the procedures outlined in the Work Plan. Sample contents were placed in a sorting tray where organisms were picked out from the debris, counted, and placed into vials. The organisms were later identified by a taxonomist down to the lowest practical taxonomic level using distinguishing traits observed under a microscope, counted, and measured. Fish larvae lengths (total length) were obtained for up to 30 individuals of each taxon identified in the laboratory. A calibrated ocular micrometer was used for all measurements. Early yolk-sac, or un-pigmented (pre-flexion) fish larvae were reported as unidentified fish larvae. The pre-flexion larval stage is characterized by a straight notochord (spine) and early formation of caudal fin structures on the ventral side of the notochord (Froese and Pauly 2012). The post-flexion larval stage is characterized by the caudal fin section of the notochord is at an upward angle of 45 degrees, and the ventral caudal rays and supporting elements may not be fully developed (Froese and Pauly 2012).

Most of the pre- and post-flexion fish larvae were identified to the family level. Shellfish larvae were identified down to class, order, or suborder, as appropriate. The total number of ichthyoplankton in each sample of a known filtered volume was used to calculate volume-based ichthyoplankton densities (number of eggs or larvae per 100 $m^3$).


**Figure 2: Cod End of the 300 μm Plankton Net Where the Eggs & Larvae are Collected During the Plankton Tow**

A QA/QC protocol was implemented for ichthyoplankton sorting and identification, as outlined in the Baseline Ichthyoplankton Characterization Work Plan. Detailed steps for processing, sorting, and identification of ichthyoplankton from the samples have been provided in the aforementioned Work Plan. All preserved samples have been archived for a period of 12 months in the event that it is later deemed necessary to obtain additional biometric data from the samples. Life stage characteristics of many tropical fish and shellfish remain poorly documented at the species level. Therefore, most identifications could only be assessed at the order or family level of taxonomic differentiation in the collected samples. References used in the intial and QA/QC evaluations included the following meristic keys:

- Richards, W. 2005. Early Stages of Atlantic Fishes: an identification guidse for the Western North Atlantic. Vols 1-2. Taylor and Francis Publishing, Boca Raton, FL.
- Moser, H. G. (Ed in Chief) 1984. Ontogeny and systematics of Fishes. Allen Press, Lawrence, KS.
- Leis, J. M. and B. M. Carson-Ewart. 2000. Fauna Malesiana: The Larvae of Indo-Pacific Coastal Fishes. Brill Press, Boston, MA.

- Todd, C. D., M. S. Laverack & G. A. Boxshall. 1996. Coastal Marine Zooplankton: a practical manual for students. Cambridge University Press, Cambridge, UK..
- W.J. Richards, K. C. Lindeman J. L. Shultz J. M. Leis A. Roepke M. E. Clarke and B. H. Comyns, 1994. Preliminary Guide to the Identification of the Early Life History Stages of Lutjanid Fishes from the Western Central Atlantic. NOAA Technical Memorandum NMFS-SEFSC-345.
- Farooqi, T.R., F. Shaw and J.G. Ditty, 1995. Preliminary Guide to the Identification of the Early Life History Stages of Anchovies (Engraulidae) from the Western Central Atlantic. NOAA technical Memorandum NMFS-SEFSC-345.
- Victor, B. Guide to the Larval Reef Fishes of the Carribbean (www.coralreeffish.com/larvae.html).

Final QA/QC of the May 2012 sample set was completed in April 2013. At a minimum, seven samples were required to be reassessed in the QA/QC program. Implementation of the QA/QC process resulted in re-evaluation of 13 of the 16 samples to meet the 10% reidentification and re-enumeration standard for fish eggs and larvae. Taxonomic reidentification fully met the 10% reidentification assessment in the QA/QC assessment. The application of a ±10% re-enumeration error for smaller invertebrate larvae was not able to be achieved in select samples due to the presence of greater quantities of fine organic matter (FOM). The greater density of FOM in these samples caused the smaller larvae to clump in aggregation within the FOM, making sorting and identification more difficult. All samples with elevated FOM were able to meet a <15% re-enumeration standard for smaller invertebrate larvae. The 10% reidentification standard for fish eggs and larvae was met for all examined samples. The QA/QC of the evaluated samples was conducted by Dr. Jorge G. Garcia, Ph.D of the University opf Puerto Rico at Mayaguez. In most instances, QA/QC enumeration data pointed to a slight underestimate in total numbers by the original identifier. These higher QA/QC values were adopted for entrainment estimates so as to reflect a conservative estimate in taxa density. The technical memorandum detailing the methods and findings of the QA/QC program is provided in Appendix II.

### 3.6 Entrainment Estimates

The ichthyoplankton sampling provided baseline data to characterize the projected entrainment densities and composition of fish and shellfish taxa at the proposed project location. The taxa present in the water column have the potential to become entrained in the cooling water intake of the FSRU or LNGC vessels while moored at the berthing platform. Using this ichthyoplankton data combined with the design flow of the cooling water intake pumps, an annual entrainment estimate was calculated for the FSRU and LNGC vessels, prior to the construction of the vessel mooring and berthing structure.

The QA/QC evaluated data for fish and shellfish present in each sample were converted to density estimates (number of fish and shellfish per unit volume). Diel abundance patterns were also evaluated by comparing the densities observed for the "day" and "night" samples. Seasonal abundance patterns could not be evaluated because these preliminary data represent a single daytime and nighttime sampling event (23 May 2012).

The total densities of ichthyoplankton (fish and shellfish) collected within the project area from this single sampling event were extrapolated to flow-based estimates for the vessel over the course of a 24-hour period, accounting for 12 hours of daytime and 12 hours of nighttime. Daily flow-based entrainment of the vessel was estimated for each species by multiplying the ichthyoplankton density (number of fish and shellfish per sample volume) by the total design flow volume of cooling water intake for the entire vessel (shown below). Annual flow-based entrainment was also calculated in this manner.

$$\frac{\text{(Total Number of fish or shellfish collected during the plankton tow)}}{\text{(Total Volume of water filtered during the plankton tow)}} = \frac{(\boldsymbol{X}\text{ number of estimated fish or shellfish entrained by the vessel)}}{\text{(Volume of cooling water used by the FSRU vessel while berthed within the project area)}}$$

The entrainment estimate value obtained for *X* above represents the entrainment value for each day/night sampling period. This value is then multiplied by the number of operation days (an assumed 365 for the FSRU vessel) or the number of deliveries within a year. For the LNGC vessels, there are an anticipated 50 deliveries scheduled each year with each having a maximum berthing duration of 88 hours. For the purposes of this analysis, it is assumed that the daytime & nighttime portions during this period would be approximately equal (12 hrs each for all calendar days of FSRU operations, and 44 hrs each for a 88 hr LNGC berthing time). However, it is understood that actual operations and variations in day versus night entrainment may vary from this depending on the actual arrival/departure times of the LNGC vessel to the offloading facility.

The total number of entrained fish and shellfish during the 12-month sampling period was estimated for each species by multiplying the total volume-based density (number of fish and shellfish per unit volume) by the total volume of cooling water used by the facility during the course of a year, by solving for *X* as shown above and accounting for the frequency and duration of the FSRU delivery schedule:

Two flow scenarios were evaluated with this entrainment estimate:

- design flows for the FSRU vessel with continuous operation in the project area.
- design flows for the LNGC vessel during a 88 hour berthing period (50 deliveries per year) for cooling water and non-ballast water intake. It was assumed that significant ballast water intake will only occur during the LNG off-loading duration For ballast water intake duration, a period of 72 hours was applied from Table 1.0.

FSRU and LNGC scenarios assumed maximum full-flow operations while each vessel is stationed at the Gas Port facility. Each of the two operating scenarios were representative of different flow volumes of cooling water, which in turn correspond to differences in the estimated impact of entrainment.

Entrained eggs, pre-flexion larvae, and post-flexion larvae were classified as such, based on laboratory evaluation of life stage. Additional length-at-age, natural mortality, and other demographic information can be used to model the age-1 equivalent adult loss estimates. Such information and analysis is beyond the scope of this report, but may be necessary as part of a more comprehensive 316(b) Demonstration Study, or verification monitoring plan, if required by permitting agencies.

Since only a single sampling event was used to estimate annual entrainment, the annual projections should be considered preliminary only until such a time that seasonal data are obtained within the project area.

### 3.7 Water Quality

Measurements for water temperature, dissolved oxygen, pH, conductivity or salinity, and turbidity were taken from near the bottom, mid-depth, and just below the surface at the end of each transect following a plankton tow. A calibrated Yellow Springs Instrument (YSI) Company sonde and water quality meter (YSI-6850 sonde, attached to a YSI-650 meter) was used for all water quality parameters. In addition, a Conductivity, Temperature, and Depth (CTD) sensor (*Sea Bird Electronics*, Model 19) was deployed at four transects (two during the daytime samples and two during nighttime samples). For YSI measurements, temperature-corrected conductivity was converted to salinity using the following algorithm:

Salinity = -100 ln(1-$C_{25}$/178,500) where $C_{25}$ = conductivity adjusted to 25°C.

# 4. RESULTS

## 4.1 Ichthyoplankton Occurrence & Density

A total of 16 plankton samples were collected on 23 May 2012 from four transects (Figure 1) during daytime (D) and nighttime (N) sampling as shown in Table 3. Each sample contained the filtered plankton from an average of 215.4 $m^3$ of towed sea water. The filtered volumes collected were conservatively higher than the targeted minimum volume of 100 $m^3$. The sample collection time, taxa/abundance and and volume charateristics for the entrainment sample event are listed in Table 3.

**Table 3: Sample Identification, Volumes, Number of Taxa, and Total Abundance for all Ichthyoplankton Samples Collected during the 23 May 2012 Sampling Event**

| Transect | | Time of Sampling | Bongo A=left, B=right | Sample ID | Field Filtered Volume ($m^3$) | Number of Taxa | Total Abundance |
|---|---|---|---|---|---|---|---|
| 1 | *Day* | 1519 | A | T1A-D | 202.3 | 17 | 5,747 |
| | | | B | T1B-D | 199.4 | 20 | 7,895 |
| | ***Night*** | 2215 | A | T1A-N | 205.6 | 23 | 7,473 |
| | | | B | T1B-N | 205.4 | 23 | 7,354 |
| 2 | *Day* | 1448 | A | T2A-D | 202.3 | 18 | 5,481 |
| | | | B | T2B-D | 167.4 | 22 | 6,995 |
| | ***Night*** | 2156 | A | T2A-N | 253.1 | 18 | 8,636 |
| | | | B | T2B-N | 251.1 | 24 | 9,275 |
| 3 | *Day* | 1415 | A | T3A-D | 220.6 | 16 | 4,903 |
| | | | B | T3B-D | 219.7 | 23 | 7,401 |
| | ***Night*** | 2117 | A | T3A-N | 221.7 | 14 | 7,588 |
| | | | B | T3B-N | 218.9 | 22 | 6,165 |
| 4 | *Day* | 1604 | A | T4A-D | 208.3 | 16 | 4,252 |
| | | | B | T4B-D | 211.4 | 17 | 5,334 |
| | ***Night*** | 2045 | A | T4A-N | 231.7 | 23 | 5,904 |
| | | | B | T4B-N | 227.8 | 28 | 5,609 |
| **Average Volume Collected** | | | | | **215.4** | | |
| **Average Filtering Efficiency** | | | | | **99.8%** | | |
| **Total Number of Unique Taxa Collected** | | | | | | **48** | |
| **Total Number of Individual Organisms Quantified** | | | | | | | **105,972** |

All ichthyoplankton combined represented 40 families, and shellfish represented five groups (Table 3). Five of the 45 taxa collected (shrimp, fish eggs, crabs, gastropods, and sardines/anchovies) accounted for 97% of the total abundance. Shrimp larvae were the dominant taxa collected, representing 60 percent of the total catch, as shown in Figure 4. Fish eggs were the dominant fish lifestage collected, representing 22 percent of the total catch. Other relatively abundant larvae included the true crabs (8 percent), gastropods (5 percent), and the Clupeiformes (sardines/anchovies, 2 percent). All of the remaining 40 taxa combined accounted for only 3 percent of the total organisms collected. Shrimps, crabs, gastropods, and clupeid fishes are abundant primary and secondary consumers in the water column, therefore it is not surprising that these organisms were the most abundant taxa in the ichthyoplankton samples.

Length data (total length in millimeters) for larval fish and shellfish are shown in Table 4.

**Table 4: Total Length (mm) Data for Larval Fish Collected during the 23 May 2012 Sampling Event**

| TAXA | # measured | MIN | MAX | MEAN | STDEV |
|---|---|---|---|---|---|
| Antennariidae | 3 | 15.0 | 20.0 | 17.0 | 2.64 |
| Apogonidae | 1 | 6.5 | 6.5 | 6.5 | -- |
| Atherinidae | 12 | 2.8 | 5.4 | 3.4 | 0.805 |
| Balistidae | 1 | 3.0 | 3.0 | 3.0 | -- |
| Bothidae | 1 | 10.0 | 10.0 | 10.0 | -- |
| Bythitidae | 1 | 4.8 | 4.8 | 4.8 | -- |
| Callyonimidae | 7 | 3.0 | 8.0 | 5.9 | 1.67 |
| Carangidae | 38 | 1.6 | 5.1 | 2.9 | 0.804 |
| Clupeiformes | 542 | 1.0 | 5.5 | 3.4 | 0.752 |
| Clupeidae | 360 | 4.2 | 35.0 | 7.5 | 2.57 |
| Eleotridae | 1 | 8.0 | 8.0 | 8.0 | -- |
| Engraulidae | 45 | 4.2 | 10.0 | 5.7 | 1.27 |
| Ephiphidae | 1 | 3.1 | 3.1 | 3.1 | -- |
| Exocoetidae | 3 | 3.0 | 3.0 | 3.0 | 0 |
| Gerreidae | 35 | 2.0 | 4.5 | 2.8 | 0.511 |
| Gobiesocidade | 16 | 2.0 | 4.0 | 2.4 | 0.504 |
| Gobiidae | 239 | 1.5 | 13.0 | 3.4 | 1.70 |
| Haemulidae | 287 | 1.5 | 9.0 | 3.8 | 1.27 |
| Hemiramphidae | 9 | 1.5 | 10.0 | 4.9 | 2.56 |
| Labridae | 64 | 2.0 | 10.5 | 2.7 | 1.26 |
| Lutjanidae | 75 | 1.7 | 6.5 | 4.5 | 0.732 |
| Microdesmidae | 10 | 3.2 | 20.0 | 6.9 | 4.76 |
| Monacanthidae | 5 | 2.0 | 20.0 | 7.1 | 7.31 |

| | | | | | |
|---|---|---|---|---|---|
| Mugilidae | 1 | 6.0 | 6.0 | 6.0 | -- |
| Myctophidae | 2 | 14.0 | 15.0 | 14.5 | 0.707 |
| Nemichthyidae | 1 | 5.0 | 5.0 | 5.0 | -- |
| Ophicthyidae | 2 | 15.0 | 43.0 | 29.0 | 19.8 |
| Opistognathidae | 4 | 3.7 | 4.3 | 3.9 | 0.287 |
| Ostraciidae | 1 | 9.0 | 9.0 | 9.0 | -- |
| Pomacanthidae | 16 | 1.4 | 8.5 | 2.7 | 1.62 |
| Pomacentridae | 219 | 0.1 | 6.0 | 2.1 | 0.589 |
| Scaridae | 20 | 3.2 | 11.0 | 8.4 | 2.00 |
| Sciaenidae | 4 | 2.0 | 4.0 | 3.1 | 0.822 |
| Scombridae | 13 | 3.0 | 8.6 | 5.1 | 1.77 |
| Scorpaenidae | 1 | 5.0 | 5.0 | 5.0 | -- |
| Serranidae | 8 | 2.2 | 4.6 | 3.5 | 0.910 |
| Sphyraenidae | 40 | 1.5 | 7.0 | 3.3 | 1.29 |
| Syngnathidae | 99 | 3.0 | 13.5 | 5.6 | 1.59 |
| Tetraodontidae | 2 | 1.5 | 2.0 | 1.8 | 0.353 |
| Tetraodontiformes | 2 | 2.0 | 2.0 | 2.0 | 0 |
| Tripterigiidae | 27 | 2.3 | 4.5 | 3.0 | 0.486 |
| Unidentified Larvae | 671 | 0.1 | 3.0 | 1.8 | 0.461 |
| Yolk-sac Larvae | 10 | 0.8 | 2.0 | 1.1 | 0.333 |

- Standard deviation not calculated

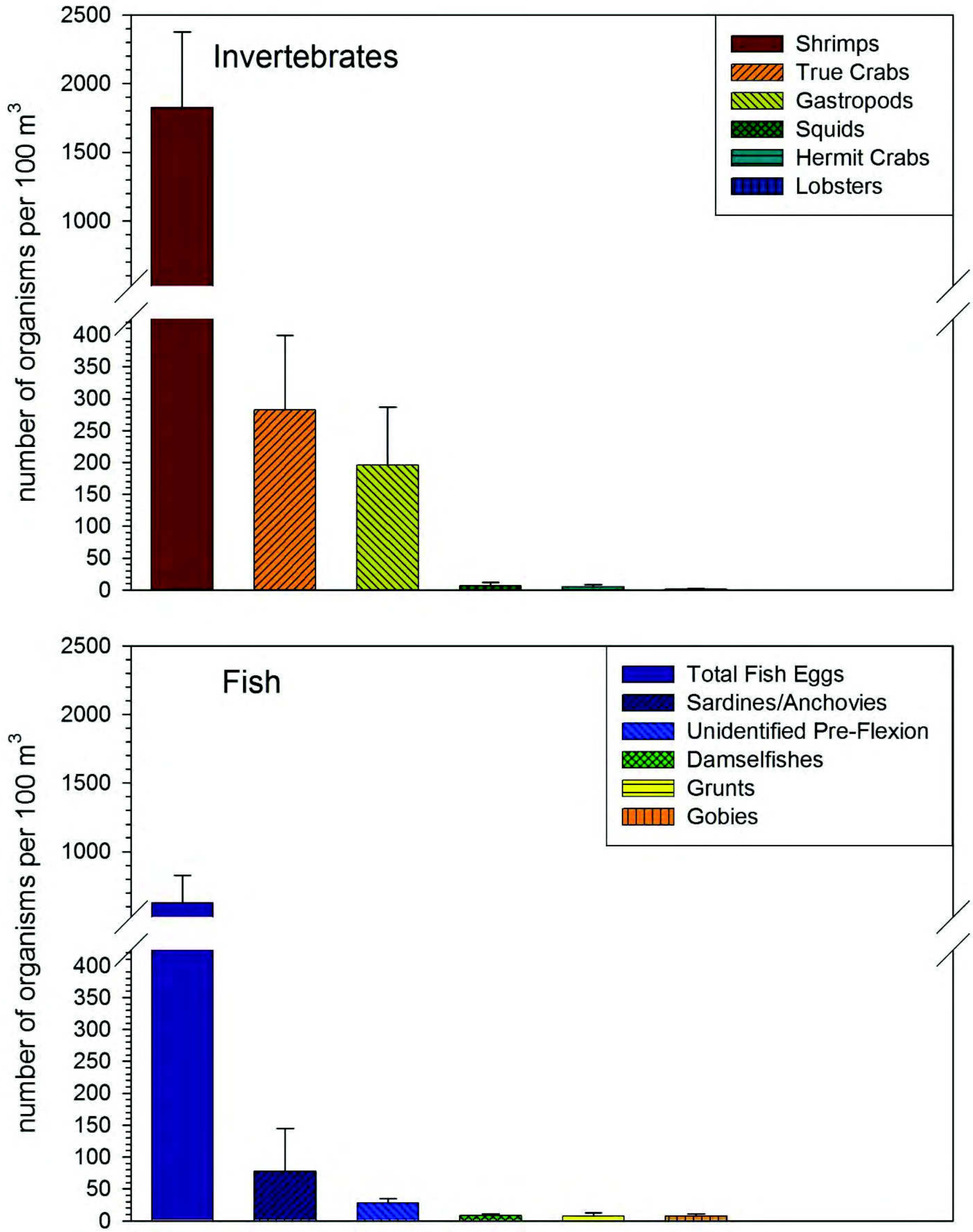


**Figure 3: Mean density (± one standard deviation) of the most abundant invertebrate taxa (upper panel) and fish taxa (lower panel) collected across all transects. Data shown account for > 99% of total relative abundance. Note break in scale for clarity.**

Abundance and richness was somewhat evenly distributed among the four transects. Much of the observed differences are due to the random distribution of ichthyoplankton in the water column between the four transects – particularly for those taxa with only a few occurrences (i.e., taxa with only one or two individuals identified in the sample set collected). The random distribution of ichthyoplankton and their settlement patterns combined with the prevailing oceanographic conditions (e.g., winds, currents) and available habitat likely accounted for some of the observed differences in abundance and diversity between transects, as shown in Table 6.

Differences in daytime and nighttime samples were apparent for pre- and post-flexion fish larvae. Mean nighttime densities of post-flexion larvae were ten times greater for post-flexion larvae, compared to daytime densities, primarily attributable to sardines. Mean nighttime densities of pre-flexion larvae were twice that of daytime densities, also primarily attributable to sardines. Mean nighttime densities of post-flexion snappers were four times greater than during the daytime. Mean nighttime densities of post-flexion grunts were five times greater than during the daytime. Mean egg densities of were greatest during the daytime, with an average of 757 eggs per 100 $m^3$, versus night (463 per 100 $m^3$). Collectively, any differences between the daytime and nighttime samples for each life stage was within the variability between transects. Figure 4 shows the comparison of abundances for post and pre-flexion fish larvae, fish eggs and invertebrate larvae quantified between day and night samples.

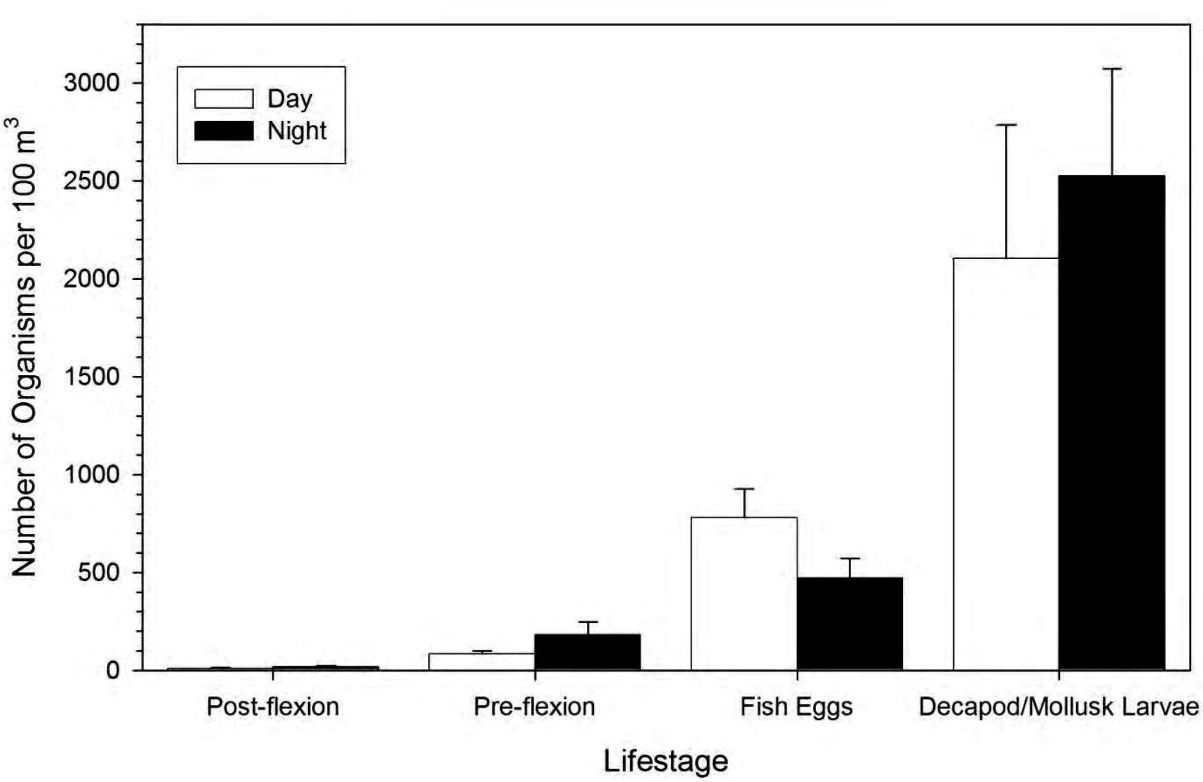


**Figure 4: Mean density (± one standard deviation) of the lifestages collected from all day and night transects (n=8 Day, 8 Night).**

Table 5 through7  summarize the identification, numbers, densities, and size distribution of ichthyoplankton collected during the 23 May 2012 sampling event.

**Table 5: Species List of all Ichthyoplankton Collected at the Project Area, and the Representation Among Lifestages. The Five Most Abundant Groups are Highlighted in Orange.**

| Phylum | Class | Order | Family | Common Name | Lifestages Collected | Percent Abundance |
|---|---|---|---|---|---|---|
| **Fish** | | | | | | |
| Chordata | Actinopterygii | Anguilliformes | Nemichthyidae | Snipe eels | pre-flexion | < 0.01% |
| | | Atheriniformes | Atherinidae | Silversides | pre-flexion, post-flexion | 0.01% |
| | | Beloniformes | Hemiramphidae | Half-beaks | pre-flexion, post-flexion | 0.01% |
| | | | Exocoetidae | Flying fishes | post-flexion | < 0.01% |
| | | Beryciformes | Berycidae | Redfishes/Alfonsinos | pre-flexion | < 0.01% |
| | | Clupeiformes | Clupeidae-Engraulidae | Sardines-Anchovies | pre-flexion | 2.63% |
| | | Gobiesociformes | Gobiesocidae | Clingfishes | pre-flexion, post-flexion | 0.02% |
| | | Lophiiformes | Antennariidae | Frogfishes | post-flexion | < 0.01% |
| | | Myctophiphormes | Myctophidae | Myctophids | post-flexion | < 0.01% |
| | | Mugiliformes | Mugilidae | Mullets | post-flexion | < 0.01% |
| | | Ophidiiformes | Ophidiidae | Cusk Eels | post-flexion | < 0.01% |
| | | | Bythitidae | Brotulas | post-flexion | < 0.01% |
| | | Perciformes | Apogonidae | Cardinalfishes | post-flexion | < 0.01% |
| | | | Callionymidae | Dragonets | post-flexion | 0.01% |
| | | | Carangidae | Jacks | pre-flexion, post-flexion | 0.04% |
| | | | Coryphaenidae | Dolphinfishes | post-flexion | < 0.01% |
| | | | Eleotridae | Sleepers | post-flexion | < 0.01% |
| | | | Ephippidae | Spadefishes | post-flexion | < 0.01% |
| | | | Gerreidae | Mojarras | pre-flexion, post-flexion | 0.04% |
| | | | Gobiidae | Gobies | pre-flexion, post-flexion | 0.23% |
| | | | Haemulidae | Grunts | pre-flexion, post-flexion | 0.25% |
| | | | Labridae | Wrasses | pre-flexion, post-flexion | 0.06% |
| | | | Lutjanidae | Snappers | pre-flexion, post-flexion | 0.09% |
| | | | Microdesmidae | Wormfishes | pre-flexion, post-flexion | 0.01% |
| | | | Opistognathidae | Jawfishes | pre-flexion | < 0.01% |
| | | | Pleuronectiformes | Flounders | post-flexion | 0.01% |
| | | | Pomacanthidae | Angelfishes | pre-flexion, post-flexion | < 0.01% |

| Phylum | Class | Order | Family | Common Name | Lifestages Collected | Percent Abundance |
|---|---|---|---|---|---|---|
| | | | Pomacentridae | Damselfishes | pre-flexion, post-flexion | 0.26% |
| | | | Scaridae | Parrotfishes | pre-flexion, post-flexion | 0.02% |
| | | | Sciaenidae | Drums/Croakers | pre-flexion, post-flexion | < 0.01% |
| | | | Scombridae | Tunas/Mackerels | pre-flexion, post-flexion | 0.01% |
| | | | Serranidae | Groupers | pre-flexion, post-flexion | 0.01% |
| | | | Sphyraenidae | Barracudas | pre-flexion, post-flexion | 0.04% |
| | | | Tripterygiidae | Triplefin Blennies | pre-flexion, post-flexion | 0.05% |
| | | Scorpaeniformes | Scorpaenidae | Scorpionfishes | pre-flexion | < 0.01% |
| | | Syngnathiformes | Syngnathidae | Pipefishes | post-flexion | 0.10% |
| | | Tetraodontiformes | Balistidae | Triggerfishes | pre-flexion | < 0.01% |
| | | | Monacanthidae | Filefishes | pre-flexion, post-flexion | < 0.01% |
| | | | Ostraciidae | Trunkfishes | post-flexion | < 0.01% |
| | | | Tetraodontidae | Porcupinefishes | pre-flexion | < 0.01% |
| | | Unknown egg | | | egg | 20.02% |
| | | Unknown larvae | | | pre-flexion | 0.92% |
| **Shellfish** | | | | | | |
| Arthropoda | Crustacea | Decapoda | Anomura | hermit crabs | larvae | 0.10% |
| | | | Brachyura | true crabs | larvae | 9.15% |
| | | | Natantia | shrimp/prawns | larvae | 59.45% |
| | | | Panilura | lobsters | larvae | 0.01% |
| Mollusca | Gastropoda | | | snails | larvae | 6.22% |
| | Bivalvia | | | clams | larvae | 0.00% |
| | Cephalopoda | Teuthoidea | | squids | larvae | 0.20% |

**Orange highlighted taxa represent dominant taxonomic groups collected**

**Table 6: Total Number and Density of Ichthyoplankton Collected for each Transect—DAYTIME**

| | | T1A-D | | T1B-D | | T2A-D | | T2B-D | | T3A-D | | T3B-D | | T4A-D | | T4B-D | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxa | Common Name | Numbers | Density (#/100 m$^3$) | Numbers | Density (#/100 m$^3$) | Numbers | Density (#/100 m$^3$) | Numbers | Density (#/100 m$^3$) | Numbers | Density (#/100 m$^3$) | Numbers | Density (#/100 m$^3$) | Numbers | Density (#/100 m$^3$) | Numbers | Density (#/100 m$^3$) |
| **Fish** | | | | | | | | | | | | | | | | | |
| **Eggs** | | | | | | | | | | | | | | | | | |
| Unidentified Egg | | **1602** | **791.9** | **1764** | **884.7** | **1543** | **762.7** | **1562** | **933.1** | **1880** | **852.2** | **1949** | **887.1** | **1320** | **633.7** | **1054** | **498.6** |
| **Post-flexion larvae** | | | | | | | | | | | | | | | | | |
| Ophidiidae | Cusk Eels | | | | | | | | | 1 | 0.45 | 1 | 0.46 | | | | |
| Bythitidae | Brotulas | | | | | | | 1 | 0.60 | | | | | | | | |
| Clupeidae | Sardines | | | | | | | | | | | | | | | | |
| Engraulidae | Anchovies | | | | | | | | | | | | | | | | |
| Exocoetidae | Flyingfishes | | | | | | | | | | | | | | | | |
| Atherinidae | Silversides | | | | | | | 1 | 0.60 | | | | | | | | |
| Ephippidae | Spadefishes | | | | | | | | | | | | | | | | |
| Gobiesocidae | Clingfishes | | | | | | | | | | | | | | | | |
| Microdesmidae | Wormfishes | 2 | 0.99 | | | | | | | | | | | | | 1 | 0.47 |
| Callyonimidae | Dragonets | | | | | | | | | | | | | | | | |
| Mugilidae | Mullets | | | | | | | | | | | | | | | 1 | 0.47 |
| Gerreidae | Mojarras | | | | | | | | | | | | | | | 1 | 0.47 |
| Sciaenidae | Drums and Croakers | | | | | | | | | | | | | | | | |
| Labridae | Wrasses | | | 1 | 0.50 | | | | | | | | | | | | |
| Lutjanidae | Snappers | 1 | 0.49 | | | | | 3 | 1.79 | | | | | 2 | 0.96 | | |
| Serranidae | Groupers | | | | | | | | | | | | | | | | |
| Syngnathidae | Pipefishes | 10 | 4.94 | 14 | 7.02 | 8 | 3.95 | 7 | 4.18 | 7 | 3.17 | 1 | 0.46 | 7 | 3.36 | 1 | 0.47 |
| Haemulidae | Grunts | 2 | 0.99 | 1 | 0.50 | 4 | 1.98 | 7 | 4.18 | 1 | 0.45 | 1 | 0.46 | 2 | 0.96 | 2 | 0.95 |
| Carangidae | Jacks | | | 1 | 0.50 | | | 2 | 1.19 | | | | | | | | |
| Scaridae | Parrotfishes | | | 1 | 0.50 | | | | | | | | | | | | |
| Tripterygiidae | Triplefin Blennies | | | | | | | | | | | | | | | | |
| Eleotrididae | Sleepers | | | | | | | | | | | | | | | | |
| Gobiidae | Gobies | 2 | 0.99 | 8 | 4.01 | 1 | 0.49 | 6 | 3.58 | 1 | 0.45 | 6 | 2.73 | 6 | 2.88 | 3 | 1.42 |
| Hemiramphidae | Half-beaks | | | | | | | | | | | | | | | | |
| Anthenaridae | Frogfishes | | | | | | | | | 2 | 0.91 | 1 | 0.46 | | | | |
| Apogonidae | Cardinalfishes | | | | | | | | | | | | | | | 1 | 0.47 |
| Monacanthidae | Filefishes | | | | | | | 1 | 0.60 | | | | | | | | |
| Pomacentridae | Damselfishes | | | | | 1 | 0.49 | | | | | | | | | | |
| Pomacanthidae | Angelfishes | | | | | | | | | | | | | | | | |
| Ostraciidae | Trunkfishes | | | | | | | | | | | | | | | | |

| | | T1A-D | | T1B-D | | T2A-D | | T2B-D | | T3A-D | | T3B-D | | T4A-D | | T4B-D | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Taxa** | **Common Name** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** |
| Sphyraenidae | Barracudas | | | 2 | 1.00 | | | 1 | 0.60 | 1 | 0.45 | 4 | 1.82 | | | | |
| Scombridae | Tunas/Mackerels | | | | | | | | | | | 1 | 0.46 | | | | |
| Myctophidae | Myctophids | | | | | | | | | | | | | | | | |
| Pleuronectiformes | Flounders | | | | | | | | | | | | | | | | |
| Coryphaenidae | Dolphinfishes | | | | | | | | | 1 | 0.45 | | | | | | |
| **Total Post-flexion** | | **17** | **8.4** | **28** | **14.0** | **14** | **6.9** | **29** | **17.3** | **14** | **6.3** | **15** | **6.8** | **17** | **8.2** | **10** | **4.7** |
| **Pre-flexion** | | | | | | | | | | | | | | | | | |
| Nemichthyidae | Snipe eels | | | | | | | | | | | | | | | | |
| Clupeiformes | Sardines/Anchovies | 59 | 29.16 | 81 | 40.62 | 56 | 27.68 | 46 | 27.48 | 63 | 28.56 | 54 | 24.58 | 93 | 44.65 | 86 | 40.68 |
| Clupeidae | Sardines | | | | | | | | | | | | | | | | |
| Engraulidae | Anchovies | | | | | | | | | | | | | | | | |
| Atherinidae | Silversides | | | | | | | | | | | 1 | 0.46 | | | | |
| Microdesmidae | Wormfishes | | | 1 | | | | | | | | 2 | 0.91 | | | | |
| Berycidae | Redfishes | | | | | | | | | | | | | | | | |
| Gobiesocidae | Clingfishes | | | 2 | 1.00 | 2 | 0.99 | 2 | 1.19 | | | | | 3 | 1.44 | | |
| Gerreidae | Mojarras | 3 | 1.48 | 3 | 1.50 | 1 | 0.49 | 3 | 1.79 | | | 2 | 0.91 | 2 | 0.96 | 10 | 4.73 |
| Sciaenidae | Drums and Croakers | | | | | | | | | | | | | | | | |
| Lutjanidae | Snappers | 1 | 0.49 | 3 | | 3 | 1.48 | 1 | 0.60 | 1 | 0.45 | 2 | 0.91 | 1 | 0.48 | | |
| Haemulidae | Grunts | 3 | 1.48 | 16 | 8.02 | 10 | 4.94 | 1 | 0.60 | 4 | 1.81 | 1 | 0.46 | 17 | 8.16 | 5 | 2.37 |
| Carangidae | Jacks | 1 | 0.49 | 1 | 0.50 | 3 | 1.48 | 2 | 1.19 | | | 1 | 0.46 | 3 | 1.44 | 3 | 1.42 |
| Tripterigiidae | Triplefin Blennies | 2 | 0.99 | 1 | 0.50 | 7 | 3.46 | 3 | 1.79 | | | 1 | 0.46 | 4 | 1.92 | | |
| Gobiidae | Gobies | 7 | 3.46 | 5 | 2.51 | 2 | 0.99 | 9 | 5.38 | | | 4 | 1.82 | 8 | 3.84 | 8 | 3.78 |
| Pomacentridae | Damselfishes | 3 | 1.48 | 9 | 4.51 | 15 | 7.41 | 12 | 7.17 | 8 | 3.63 | 20 | 9.10 | 30 | 14.40 | 16 | 7.57 |
| Pomacanthidae | Angelfishes | 1 | 0.49 | | | | | | | | | | | | | | |
| Labridae | Wrasses | 5 | 2.47 | 4 | 2.01 | | | 8 | 4.78 | | | 6 | 2.73 | 2 | 0.96 | 6 | 2.84 |
| Opistognathidae | Jawfishes | | | | | | | 3 | 1.79 | | | | | | | | |
| Hemiramphidae | Half-beaks | | | | | 2 | 0.99 | | | 1 | 0.45 | | | | | | |
| Serranidae | Groupers | | | | | 1 | 0.49 | | | | | 1 | 0.46 | | | | |
| Scaridae | Parrotfishes | | | 1 | 0.50 | | | | | | | | | | | | |
| Scorpaenidae | Scorpionfishes | | | | | | | | | | | | | | | | |
| Sphyraenidae | Barracudas | | | 2 | 1.00 | | | 1 | 0.60 | 2 | 0.91 | 7 | 3.19 | 2 | 0.96 | 4 | 1.89 |
| Scombridae | Tunas/Mackerels | | | 2 | 1.00 | | | 1 | 0.60 | | | | | | | | |
| Balistidae | Triggerfishes | | | | | | | | | | | | | | | | |
| Monacanthidae | Filefishes | | | | | | | | | | | | | | | | |
| Tetraodontidae | Porcupinefishes | | | | | | | | | | | 1 | 0.46 | | | | |

| | | T1A-D | | T1B-D | | T2A-D | | T2B-D | | T3A-D | | T3B-D | | T4A-D | | T4B-D | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Taxa** | **Common Name** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** |
| Unidentified | | 67 | 33.1 | 64 | 32.1 | 54 | 26.69 | 52 | 31.06 | 38 | 17.23 | 50 | 22.76 | 54 | 25.92 | 74 | 35.00 |
| **Total Pre flexion** | | **152** | **75.1** | **195** | **97.8** | **156** | **77.1** | **144** | **86.0** | **117** | **53.0** | **153** | **69.6** | **219** | **105.1** | **212** | **100.3** |
| **Decapod/Mollusk/Cephalopods** | | | | | | | | | | | | | | | | | |
| **Larvae** | | | | | | | | | | | | | | | | | |
| Section Anomura | Hermit Crabs | 8 | **4.0** | 4 | **2.0** | 8 | **4.0** | 20 | **11.9** | 4 | **1.8** | 12 | **5.5** | | | 8 | **3.8** |
| Section Brachyura | True Crabs | 316 | **156.2** | 1040 | **521.6** | 400 | **197.7** | 688 | **411.0** | 720 | **326.4** | 640 | **291.3** | 440 | **211.2** | 560 | **264.9** |
| Sub-Order Natantia | Shrimps | 3212 | **1587.7** | 4100 | **2056.2** | 2700 | **1334.7** | 3964 | **2368.0** | 1880 | **852.2** | 4216 | **1919.0** | 2048 | **983.2** | 2874 | **1359.5** |
| Sub-Order Panilura | Lobsters | | | | | 4 | **2.0** | | | | | | | | | | |
| Class Gastropoda | Gastropods | 428 | **211.6** | 760 | **381.1** | 640 | **316.4** | 520 | **310.6** | 280 | **126.9** | 400 | **182.1** | 200 | **96.0** | 600 | **283.8** |
| Order Teuthoidea | Squids | 12 | **5.9** | 4 | **2.0** | 16 | **7.9** | 28 | **16.7** | 8 | **3.6** | 16 | **7.3** | 8 | **3.8** | 16 | **7.6** |
| **Total Decapod/Mollusk/Cephalopod Larvae** | | **3976.0** | **1965.4** | **5908.0** | **2962.9** | **3768.0** | **1862.6** | **5220.0** | **3118.3** | **2892.0** | **1311.0** | **5284.0** | **2405.1** | **2696.0** | **1294.3** | **4058.0** | **1919.6** |

**Table 7: Total Number and Density of Ichthyoplankton Collected for each Transect—NIGHTTIME**

| | | T1A-N | | T1B-N | | T2A-N | | T2B-N | | T3A-N | | T3B-N | | T4A-N | | T4B-N | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Taxa** | **Common Name** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** |
| **Fish** | | | | | | | | | | | | | | | | | |
| **Eggs** | | | | | | | | | | | | | | | | | |
| Unidentified Egg | | **962** | **467.9** | **1129** | **549.7** | **1240** | **489.9** | **992** | **395.1** | **1149** | **518.3** | **1000** | **456.8** | **1421** | **613.3** | **650** | **285.3** |
| **Post-flexion** | | | | | | | | | | | | | | | | | |
| Ophidiidae | Cusk Eels | | | | | | | | | | | | | | | | |
| Bythitidae | Brotulas | | | | | | | | | | | | | | | | |
| Clupeidae | Sardines | | | | | | | | | | | | | | | | |
| Engraulidae | Anchovies | | | | | | | | | | | | | | | | |
| Exocoetidae | Flyingfishes | | | 2 | 0.97 | | | 2 | 0.80 | | | | | | | | |
| Atherinidae | Silversides | | | | | | | 1 | 0.40 | | | | | | | | |
| Ephippidae | Spadefishes | | | 1 | 0.49 | | | | | | | | | | | | |
| Gobiesocidae | Clingfishes | | | | | | | | | | | | | 2 | 0.86 | | |
| Microdesmidae | Wormfishes | 2 | 0.97 | 1 | 0.49 | | | | | | | | | 4 | 1.73 | 2 | 0.88 |
| Callyonimidae | Dragonets | 3 | 1.46 | 2 | 0.97 | 1 | 0.40 | 1 | 0.40 | | | | | | | | |
| Mugilidae | Mullets | | | | | | | | | | | | | | | | |
| Gerreidae | Mojarras | | | | | | | | | | | | | | | 1 | 0.44 |
| Sciaenidae | Drums and Croakers | | | | | | | 2 | 0.80 | | | | | | | | |
| Labridae | Wrasses | | | | | | | | | | | | | | | 1 | 0.44 |
| Lutjanidae | Snappers | 4 | 1.95 | 6 | 2.92 | 4 | 1.58 | 6 | 2.39 | 7 | 3.16 | 3 | 1.37 | 8 | 3.45 | 9 | 3.95 |
| Serranidae | Groupers | 1 | 0.49 | | | 1 | 0.40 | | | | | | | 1 | 0.43 | | |
| Syngnathidae | Pipefishes | 6 | 2.92 | 11 | 5.36 | 4 | 1.58 | 7 | 2.79 | 4 | 1.80 | 4 | 1.83 | 8 | 3.45 | 6 | 2.63 |
| Haemulidae | Grunts | 14 | 6.81 | 11 | 5.36 | 9 | 3.56 | 20 | 7.96 | 7 | 3.16 | 17 | 7.77 | 7 | 3.02 | 12 | 5.27 |
| Carangidae | Jacks | | | | | 1 | 0.40 | | | 2 | 0.90 | | | | | 1 | 0.44 |
| Scaridae | Parrotfishes | | | 2 | 0.97 | | | 4 | 1.59 | | | 4 | 1.83 | 1 | 0.43 | 7 | 3.07 |
| Tripterygiidae | Triplefin Blennies | | | | | | | | | | | | | 3 | 1.29 | | |
| Eleotrididae | Sleepers | | | | | | | | | | | 1 | 0.46 | | | | |
| Gobiidae | Gobies | 2 | 0.97 | 8 | 3.89 | 4 | 1.58 | 7 | 2.79 | 5 | 2.26 | 6 | 2.74 | 6 | 2.59 | 15 | 6.58 |
| Hemiramphidae | Half-beaks | | | | | | | | | | | 4 | 1.83 | 1 | 0.43 | 1 | 0.44 |
| Anthenaridae | Frogfishes | | | | | | | | | | | | | 1 | 0.43 | | |
| Apogonidae | Cardinalfishes | | | | | | | | | | | | | | | | |
| Monacanthidae | Filefishes | | | | | | | | | | | | | | | 1 | 0.44 |
| Pomacentridae | Damselfishes | | | | | | | 2 | 0.80 | 9 | 4.06 | | | | | 2 | 0.88 |
| Pomacanthidae | Angelfishes | 1 | 0.49 | | | | | | | | | | | | | | |
| Ostraciidae | Trunkfishes | | | | | | | | | | | | | | | 1 | 0.44 |

| | | T1A-N | | T1B-N | | T2A-N | | T2B-N | | T3A-N | | T3B-N | | T4A-N | | T4B-N | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Taxa** | **Common Name** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** |
| Sphyraenidae | Barracudas | | | 2 | 0.97 | | | | | | | | | | | 1 | 0.44 |
| Scombridae | Tunas/Mackerels | | | | | | | 1 | 0.40 | 1 | 0.45 | 1 | 0.46 | | | | |
| Myctophidae | Myctophids | | | | | | | | | | | | | 2 | 0.86 | | |
| Pleuronectiformes | Flounders | | | | | | | | | | | | | | | 1 | 0.44 |
| Coryphaenidae | Dolphinfishes | | | | | | | | | | | | | | | | |
| **Total Post-flexion larvae** | | **33** | **16.1** | **46** | **22.4** | **24** | **9.5** | **53** | **21.1** | **35** | **15.8** | **40** | **18.3** | **44** | **19.0** | **61** | **26.78** |
| **Pre-flexion larvae** | | | | | | | | | | | | | | | | | |
| Nemichthyidae | Snipe eels | | | | | | | | | | | 1 | 0.46 | | | | |
| Clupeiformes | Sardines/Anchovies | 275 | 133.75 | 132 | 64.26 | 291 | 114.97 | 122 | 48.59 | 247 | 111.41 | 163 | 74.46 | 577 | 249.03 | 438 | 192.27 |
| Clupeidae | Sardines | | | | | | | | | | | | | | | | |
| Engraulidae | Anchovies | | | | | | | | | | | | | | | | |
| Atherinidae | Silversides | | | | | | | | | | | | | | | 8 | 3.51 |
| Microdesmidae | Wormfishes | | | | | | | | | | | | | | | | |
| Berycidae | Redfishes | | | | | | | | | | | | | | | 1 | 0.44 |
| Gobiesocidae | Clingfishes | 1 | 0.49 | 5 | 2.43 | | | 3 | 1.19 | | | 2 | 0.91 | 1 | 0.43 | 2 | 0.88 |
| Gerreidae | Mojarras | | | | | | | 4 | 1.59 | 3 | 1.35 | | | 2 | 0.86 | 4 | 1.76 |
| Sciaenidae | Drums and Croakers | | | | | | | 2 | 0.80 | | | | | | | | |
| Lutjanidae | Snappers | 2 | 0.97 | 6 | 2.92 | 4 | 1.58 | 4 | 1.59 | 4 | 1.80 | 1 | 0.46 | 5 | 2.16 | 4 | 1.76 |
| Haemulidae | Grunts | 9 | 4.38 | 14 | 6.82 | 8 | 3.16 | 31 | 12.35 | 13 | 5.86 | 9 | 4.11 | 8 | 3.45 | | |
| Carangidae | Jacks | 3 | 1.46 | 2 | 0.97 | 3 | 1.19 | 2 | 0.80 | 5 | 2.26 | 3 | 1.37 | 3 | 1.29 | 1 | 0.44 |
| Tripterigiidae | Triplefin Blennies | | | 5 | 2.43 | | | 13 | 5.18 | | | 1 | 0.46 | 5 | 2.16 | 8 | 3.51 |
| Gobiidae | Gobies | 29 | 14.11 | 9 | 4.38 | 22 | 8.69 | 10 | 3.98 | 6 | 2.71 | 11 | 5.03 | 10 | 4.32 | 16 | 7.02 |
| Pomacentridae | Damselfishes | 18 | 8.75 | 16 | 7.79 | 23 | 9.09 | 16 | 6.37 | 18 | 8.12 | 10 | 4.57 | 22 | 9.50 | 21 | 9.22 |
| Pomacanthidae | Angelfishes | | | | | | 0.00 | | | | 0.00 | | | | | 1 | 0.44 |
| Labridae | Wrasses | | | 3 | 1.46 | 4 | 1.58 | 2 | 0.80 | 3 | 1.35 | 5 | 2.28 | 3 | 1.29 | 15 | 6.58 |
| Opistognathidae | Jawfishes | | | | | | | 1 | 0.40 | | | | | | | | |
| Hemiramphidae | Half-beaks | | | | | | | | | | | | | | | | |
| Serranidae | Groupers | | | 1 | 0.49 | | | | | | | 1 | 0.46 | 1 | 0.43 | 1 | 0.44 |
| Scaridae | Parrotfishes | | | | | | | | | | | | | | | | |
| Scorpaenidae | Scorpionfishes | 1 | 0.49 | | | | | | | | | | | | | | |
| Sphyraenidae | Barracudas | 1 | 0.49 | | | 2 | 0.79 | 1 | 0.40 | 1 | 0.45 | 2 | 0.91 | 3 | 1.29 | 3 | 1.32 |
| Scombridae | Tunas/Mackerels | 1 | 0.49 | | | 1 | 0.40 | | | | | | | | | 2 | 0.88 |
| Balistidae | Triggerfishes | 1 | 0.49 | | | | | | | | | | | | | | |
| Monacanthidae | Filefishes | | | | | | | | | | | | | 1 | 0.43 | | |
| Tetraodontidae | Porcupinefishes | 2 | 0.97 | 1 | 0.49 | | | | | | | 1 | 0.46 | | | | |

| | | T1A-N | | T1B-N | | T2A-N | | T2B-N | | T3A-N | | T3B-N | | T4A-N | | T4B-N | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Taxa** | **Common Name** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** | **Numbers** | **Density (#/100 m$^3$)** |
| Unidentified | | 58 | 28.21 | 40 | 19.47 | 84 | 33.19 | 115 | 45.80 | 64 | 28.87 | 55 | 25.13 | 54 | 23.31 | 48 | 21.07 |
| **Total Pre flexion larvae** | | **401** | **195.0** | **234** | **113.9** | **442** | **174.6** | **326** | **129.8** | **364** | **164.2** | **265** | **121.1** | **695** | **300.0** | **573** | **251.5** |
| **Decapod/Mollusk/Cephalopods** | | | | | | | | | | | | | | | | | |
| **Larvae** | | | | | | | | | | | | | | | | | |
| Section Anomura | Hermit Crabs | 20 | **9.7** | | | 8 | **3.2** | 12 | **4.8** | | | | | | | 4 | **1.8** |
| Section Brachyura | True Crabs | 376 | **182.9** | 720 | **350.5** | 680 | **268.7** | 1240 | **493.8** | 520 | **234.6** | 680 | **310.6** | 308 | **132.9** | 364 | **159.8** |
| Sub-Order Natantia | Shrimps | 5280 | **2568.1** | 4840 | **2356.4** | 5950 | **2350.8** | 6000 | **2389.5** | 5280 | **2381.6** | 3720 | **1699.4** | 3236 | **1396.6** | 3702 | **1625.1** |
| Sub-Order Panilura | Lobsters | 1 | **0.5** | 1 | **0.5** | 8 | **3.2** | | | | | | | | | | |
| Class Gastropoda | Gastropods | 368 | **179.0** | 360 | **175.3** | 280 | **110.6** | 640 | **254.9** | 240 | **108.3** | 440 | **201.0** | 192 | **82.9** | 248 | **108.9** |
| Order Teuthoidea | Squids | 32 | **15.6** | 24 | **11.7** | 4 | **1.6** | 12 | **4.8** | | | 20 | **9.1** | 8 | **3.5** | 7 | **3.1** |
| **Total Decapod/Mollusk/Cephalopod Larvae** | | **6077.0** | **2955.7** | **5945.0** | **2894.4** | **6930.0** | **2738.0** | **7904.0** | **3147.7** | **6040.0** | **2724.4** | **4860.0** | **2220.2** | **3744.0** | **1615.9** | **4325.0** | **1898.6** |

## 4.2 Water Quality Data

Tabular presentation of water quality parameters recorded at each transect during the sampling event indicate no unusual patterns in specific conductance (or salinity), dissolved oxygen (DO), pH, water temperature, or turbidity (Table ). None of the water quality parameters measured appeared to limit the distribution of fishes. However, the conductivity data, and consequently the salinity data, obtained from the YSI meter were consistently lower than expected, as compared to the same data measured from the CTD.

**Table 8: Presentation of Water Quality Parameters Recorded at Each of the Transects During the Sampling Event**

| Transect ID | Day/ Night | Water Column Location | Depth (ft) | YSI-Water Temp (C°) | CTD-Water Temp (C°) | YSI-Salinty (ppt) | CTD-Salinity (ppt) | Cond. (mS/cm) | D.O. (mg/L) | D.O. (%) | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | DAY | SURFACE | 64 | 27.85 | 28.05 | 29.40 | 35.43 | 47980 | 6.26 | 93 | 8.09 |
| T1 | DAY | MID | 64 | 27.84 | 28.04 | 29.50 | 35.43 | 48090 | 6.22 | 96 | 8.09 |
| T1 | DAY | BOTTOM | 64 | 27.85 | 27.88 | 29.10 | 35.45 | 47600 | 6.49 | 101 | 8.08 |
| T1 | NIGHT | SURFACE | 63 | 27.78 | -- | 29.20 | -- | 47690 | 8.60 | 120 | 8.11 |
| T1 | NIGHT | MID | 63 | 27.78 | -- | 29.20 | -- | 47620 | 8.57 | 119 | 8.12 |
| T1 | NIGHT | BOTTOM | 63 | 27.72 | -- | 29.30 | -- | 47710 | 8.57 | 119 | 8.12 |
| T2 | DAY | SURFACE | 60 | 27.85 | 28.08 | 29.10 | 35.43 | 47590 | 7.21 | 108 | 8.07 |
| T2 | DAY | MID | 60 | 27.83 | 28.06 | 29.20 | 35.43 | 47730 | 7.16 | 110 | 8.08 |
| T2 | DAY | BOTTOM | 60 | 27.80 | 28.03 | 29.20 | 35.43 | 47640 | 8.09 | 122 | 8.08 |
| T2 | NIGHT | SURFACE | 62 | 27.81 | -- | 30.20 | -- | 49120 | 8.52 | 120 | 8.12 |
| T2 | NIGHT | MID | 62 | 27.78 | -- | 30.30 | -- | 49270 | 8.11 | 115 | 8.12 |
| T2 | NIGHT | BOTTOM | 62 | 27.80 | -- | 30.20 | -- | 49050 | 8.21 | 120 | 8.11 |
| T3 | DAY | SURFACE | 65 | 27.85 | 28.02 | 29.30 | 35.43 | 47800 | 7.62 | 106 | 8.03 |
| T3 | DAY | MID | 65 | 27.82 | 28.02 | 29.20 | 35.43 | 47630 | 7.11 | 110 | 8.04 |
| T3 | DAY | BOTTOM | 65 | 27.51 | 27.96 | 29.50 | 35.45 | 47820 | 7.08 | 108 | 8.04 |
| T3 | NIGHT | SURFACE | 65 | 27.81 | -- | 29.50 | -- | 48120 | 8.67 | 121 | 8.10 |

| Transect ID | Day/ Night | Water Column Location | Depth (ft) | YSI-Water Temp (C°) | CTD-Water Temp (C°) | YSI-Salinty (ppt) | CTD-Salinity (ppt) | Cond. (mS/cm) | D.O. (mg/L) | D.O. (%) | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| T3 | NIGHT | MID | 65 | 27.81 | -- | 29.30 | -- | 47750 | 8.12 | 122 | 8.09 |
| T3 | NIGHT | BOTTOM | 65 | 27.81 | -- | 29.10 | -- | 47580 | 7.99 | 120 | 8.09 |
| T4 | DAY | SURFACE | 62 | 27.86 | 28.08 | 29.50 | 35.42 | 48110 | 5.34 | 78 | 8.09 |
| T4 | DAY | MID | 62 | 27.88 | 28.08 | 29.50 | 35.43 | 48190 | 5.33 | 80 | 8.09 |
| T4 | DAY | BOTTOM | 62 | 27.85 | 28.07 | 29.10 | 35.43 | 47600 | 5.66 | 85 | 8.09 |
| T4 | NIGHT | SURFACE | 63 | 27.75 | -- | 29.20 | -- | 47670 | 8.65 | 121 | 8.12 |
| T4 | NIGHT | MID | 63 | 27.75 | -- | 29.30 | -- | 47770 | 7.38 | 110 | 8.13 |
| T4 | NIGHT | BOTTOM | 63 | 27.74 | -- | 29.50 | -- | 47580 | 7.84 | 117 | -- |

# 5. PROJECTED ENTRAINMENT POTENTIAL

The annual entrainment calculated for the FSRU and the LNGC vessel was based on the ichthyoplankton data collected from a single sampling event conducted on 23 May 2012. The spawning and reproductive characteristics of fishes vary on temporal and spatial scales. Therefore, it is difficult to project with certainty the entrainment levels within the FSRU vessel and the LNGC vessel based on this single sampling event. Seasonal estimates could not be determined from the single sampling event. The entrainment estimates included here should be considered preliminary until a determination of pre-construction sampling frequency is made by the resource agencies.

The total estimated number of individual fish/shellfish eggs and larvae that are projected to be entrained through the FSRU and LNGC vessel's cooling water intake on an annual basis are shown in Table 9, based on the continuous operation of the FSRU vessel and the number of LNGC vessel deliveries per year; both under the maximum flow rate scenarios shown in Table 1.

**Table 9: Total Annual Entrainment Projections for the LNGC and FSRU Vessels[1]**

| | LNG Carrier Vessel | FSRU Vessel |
|---|---|---|
| | 50 LNG Deliveries per Year | Continuous Operation |
| **Fish eggs** | 356,532,548 | 482,617,328 |
| **Fish larvae (pre-flexion)** | 75,570,250 | 102,295,043 |
| **Fish larvae (post-flexion)** | 7,812,661 | 10,575,543 |
| **Decapod Crustacean/Mollusk larvae** | 1,322,639,659 | 1,778,189,295 |
| **TOTAL** | **1,762,555,119** | **2,373,677,209** |

[1]Projected total numbers of entrained eggs and larvae are based on water intake of each vessel for an entire year.

Table 10 and Table 11 list the detailed breakouts of the taxa-specific total estimated entrainment numbers of eggs and larvae entrained for all species under each of the operational flow scenarios.

**Table 10: Estimated Total Entrainment by Species Through the FSRU Vessel Based on Design Flow Rates During a 12-month Operating Period: Continuous Operation**

| | | DAYTIME ENTRAINMENT | | NIGHTTIME ENTRAINMENT | | COMBINED TOTAL ANNUAL ENTRAINMENT |
|---|---|---|---|---|---|---|
| Taxa | Common Name | Number of individuals entrained per 12-hours of operation | Number of individuals entrained per year of operation | Number of individuals entrained per 12-hours of operation | Number of individuals entrained per year of operation | |
| **Fish** | | | | | | |
| **Eggs** | | | | | | |
| Unidentified Egg | | 823,429 | 300,551,705 | 498,810 | 182,065,622 | **482,617,328** |
| **Post-flexion larvae** | | | | | | |
| Ophidiidae | Cusk Eels | 130 | 47,428 | 0 | 0 | |
| Bythitidae | Pigmy Cods/Brotulas | 65 | 23,714 | 0 | 0 | |
| Clupeidae | Sardines | 0 | 0 | 0 | 0 | |
| Engraulidae | Anchovies | 0 | 0 | 0 | 0 | |
| Exocoetidae | Flyingfishes | 0 | 0 | 234 | 85,247 | |
| Atherinidae | Silversides | 65 | 23,714 | 58 | 21,312 | |
| Ephippidae | Spadefishes | 0 | 0 | 58 | 21,312 | |
| Gobiesocidae | Clingfishes | 0 | 0 | 117 | 42,623 | |
| Microdesmidae | Wormfishes | 195 | 71,142 | 525 | 191,805 | |
| Callyonimidae | Dragonets | 0 | 0 | 409 | 149,182 | |
| Mugilidae | Mullets | 65 | 23,714 | 0 | 0 | |
| Gerreidae | Mojarras | 65 | 23,714 | 58 | 21,312 | |
| Sciaenidae | Drums and Croakers | 0 | 0 | 117 | 42,623 | |
| Labridae | Wrasses | 65 | 23,714 | 58 | 21,312 | |
| Lutjanidae | Snappers | 390 | 142,284 | 2,744 | 1,001,649 | |
| Serranidae | Groupers | 0 | 0 | 175 | 63,935 | |
| Syngnathidae | Pipefishes | 3,573 | 1,304,272 | 2,919 | 1,065,584 | |
| Haemulidae | Grunts | 1,299 | 474,281 | 5,664 | 2,067,232 | |
| Carangidae | Jacks | 195 | 71,142 | 234 | 85,247 | |
| Scaridae | Parrotfishes | 65 | 23,714 | 1,051 | 383,610 | |
| Tripterygiidae | Triplefin Blennies | 0 | 0 | 175 | 63,935 | |
| Eleotrididae | Sleepers | 0 | 0 | 58 | 21,312 | |
| Gobiidae | Gobies | 2,144 | 782,563 | 3,095 | 1,129,519 | |
| Hemiramphidae | Half-beaks | 0 | 0 | 350 | 127,870 | |
| Anthenaridae | Frogfishes | 195 | 71,142 | 58 | 21,312 | |
| Apogonidae | Cardinalfishes | 65 | 23,714 | 0 | 0 | |
| Monacanthidae | Filefishes | 65 | 23,714 | 58 | 21,312 | |
| Pomacentridae | Damselfishes | 65 | 23,714 | 759 | 277,052 | |
| Pomacanthidae | Angelfishes | 0 | 0 | 58 | 21,312 | |
| Ostraciidae | Trunkfishes | 0 | 0 | 58 | 21,312 | |
| Sphyraenidae | Barracudas | 520 | 189,712 | 175 | 63,935 | |

| | | DAYTIME ENTRAINMENT | | NIGHTTIME ENTRAINMENT | | COMBINED TOTAL ANNUAL ENTRAINMENT |
|---|---|---|---|---|---|---|
| **Taxa** | **Common Name** | **Number of individuals entrained per 12-hours of operation** | **Number of individuals entrained per year of operation** | **Number of individuals entrained per 12-hours of operation** | **Number of individuals entrained per year of operation** | |
| Scombridae | Tunas/Mackerels | 65 | 23,714 | 175 | 63,935 | |
| Myctophidae | Myctophids | 0 | 0 | 117 | 42,623 | |
| Pleuronectiformes | Flounders | 0 | 0 | 58 | 21,312 | |
| Coryphaenidae | Dolphinfishes | 65 | 23,714 | 0 | 0 | |
| **Total Post-flexion larvae** | | **9,356** | **3,414,821** | **19,618** | **7,160,722** | **10,575,543** |
| **Pre-flexion larvae** | | | | | | |
| Nemichthyidae | Snipe eels | 0 | 0 | 58 | 21,312 | |
| Clupeiformes | Sardines/Anchovies | 34,954 | 12,758,152 | 131,081 | 47,844,706 | |
| Clupeidae | Sardines | 0 | 0 | 0 | 0 | |
| Engraulidae | Anchovies | 0 | 0 | 0 | 0 | |
| Atherinidae | Silversides | 65 | 23,714 | 467 | 170,493 | |
| Microdesmidae | Wormfishes | 195 | 71,142 | 0 | 0 | |
| Berycidae | Redfishes | 0 | 0 | 58 | 21,312 | |
| Gobiesocidae | Clingfishes | 585 | 213,426 | 817 | 298,363 | |
| Gerreidae | Mojarras | 1,559 | 569,137 | 759 | 277,052 | |
| Sciaenidae | Drums and Croakers | 0 | 0 | 117 | 42,623 | |
| Lutjanidae | Snappers | 780 | 284,568 | 1,752 | 639,350 | |
| Haemulidae | Grunts | 3,703 | 1,351,700 | 5,372 | 1,960,674 | |
| Carangidae | Jacks | 910 | 331,997 | 1,285 | 468,857 | |
| Tripterigiidae | Triplefin Blennies | 1,169 | 426,853 | 1,868 | 681,974 | |
| Gobiidae | Gobies | 2,794 | 1,019,704 | 6,598 | 2,408,219 | |
| Pomacentridae | Damselfishes | 7,342 | 2,679,686 | 8,408 | 3,068,881 | |
| Pomacanthidae | Angelfishes | 65 | 23,714 | 58 | 21,312 | |
| Labridae | Wrasses | 2,014 | 735,135 | 2,044 | 745,909 | |
| Opistognathidae | Jawfishes | 195 | 71,142 | 58 | 21,312 | |
| Hemiramphidae | Half-beaks | 195 | 71,142 | 0 | 0 | |
| Serranidae | Groupers | 130 | 47,428 | 234 | 85,247 | |
| Scaridae | Parrotfishes | 65 | 23,714 | 0 | 0 | |
| Scorpaenidae | Scorpionfishes | 0 | 0 | 58 | 21,312 | |
| Sphyraenidae | Barracudas | 1,169 | 426,853 | 759 | 277,052 | |
| Scombridae | Tunas/Mackerels | 195 | 71,142 | 234 | 85,247 | |
| Balistidae | Triggerfishes | 0 | 0 | 58 | 21,312 | |
| Monacanthidae | Filefishes | 0 | 0 | 58 | 21,312 | |
| Tetraodontidae | Porcupinefishes | 65 | 23,714 | 234 | 85,247 | |
| Unidentified | | 29,431 | 10,742,459 | 30,245 | 11,039,447 | |
| **Total Pre flexion** | | **87,580** | **31,966,522** | **192,681** | **70,328,521** | **102,295,043** |

| | | DAYTIME ENTRAINMENT | | NIGHTTIME ENTRAINMENT | | COMBINED TOTAL ANNUAL ENTRAINMENT |
|---|---|---|---|---|---|---|
| Taxa | Common Name | Number of individuals entrained per 12-hours of operation | Number of individuals entrained per year of operation | Number of individuals entrained per 12-hours of operation | Number of individuals entrained per year of operation | |
| **Decapod/Mollusk/Cephalopod** | | | | | | |
| **Larvae** | | | | | | |
| Section Anomura | Hermit Crabs | 4,158 | 1,517,698 | 2,569 | 937,714 | |
| Section Brachyura | True Crabs | 312,116 | 113,922,234 | 285,401 | 104,171,458 | |
| Sub-Order Natantia | Shrimps | 1,623,859 | 592,708,641 | 2,219,217 | 810,014,067 | |
| Sub-Order Panilura | Lobsters | 260 | 94,856 | 584 | 213,117 | |
| Class Gastropoda | Gastropods | 248,705 | 90,777,334 | 161,618 | 58,990,711 | |
| Order Teuthoidea | Squids | 7,017 | 2,561,116 | 6,248 | 2,280,349 | |
| **Total Decapod/Mollusk/Cephalopod Larvae** | | **2,196,115** | **801,581,879** | **2,675,637** | **976,607,415** | **1,778,189,295** |
| **TOTAL ANNUAL ENTRAINMENT** | **ALL TAXA/LIFESTAGES, DAY & NIGHT COMBINED** | | | | | **2,373,677,209** |

**Table 11: Estimated Total Entrainment by Species Through the LNGC Vessel Based on Design Flow Rates During a 12-month Operating Period: 50 LNG Deliveries per year**

| | | DAYTIME ENTRAINMENT | | NIGHTTIME ENTRAINMENT | | |
|---|---|---|---|---|---|---|
| Taxa | Common Name | Number of individuals entrained per 44-hours of operation | Number of individuals entrained during 50 deliveries per year | Number of individuals entrained per 44-hours of operation | Number of individuals entrained during 50 deliveries per year | COMBINED ANNUAL ENTRAINMENT (50 LNG DELIVERIES) |
| **Eggs** | | | | | | |
| **Unidentified Egg** | | 4,440,639 | 222,031,948 | 2,690,012 | 134,500,600 | **356,532,548** |
| **Post-flexion Larvae** | | | | | | |
| Ophidiidae | Cusk Eels | 701 | 35,037 | 0 | 0 | |
| Bythitidae | Pigmy Cods/Brotulas | 350 | 17,519 | 0 | 0 | |
| Clupeidae | Sardines | 0 | 0 | 0 | 0 | |
| Engraulidae | Anchovies | 0 | 0 | 0 | 0 | |
| Exocoetidae | Flyingfishes | 0 | 0 | 1,260 | 62,976 | |
| Atherinidae | Silversides | 350 | 17,519 | 315 | 15,744 | |
| Ephippidae | Spadefishes | 0 | 0 | 315 | 15,744 | |
| Gobiesocidae | Clingfishes | 0 | 0 | 630 | 31,488 | |
| Microdesmidae | Wormfishes | 1,051 | 52,556 | 2,834 | 141,696 | |
| Callyonimidae | Dragonets | 0 | 0 | 2,204 | 110,208 | |
| Mugilidae | Mullets | 350 | 17,519 | 0 | 0 | |
| Gerreidae | Mojarras | 350 | 17,519 | 315 | 15,744 | |
| Sciaenidae | Drums and Croakers | 0 | 0 | 630 | 31,488 | |
| Labridae | Wrasses | 350 | 17,519 | 315 | 15,744 | |
| Lutjanidae | Snappers | 2,102 | 105,112 | 14,799 | 739,966 | |
| Serranidae | Groupers | 0 | 0 | 945 | 47,232 | |
| Syngnathidae | Pipefishes | 19,271 | 963,528 | 15,744 | 787,198 | |
| Haemulidae | Grunts | 7,007 | 350,374 | 30,543 | 1,527,164 | |
| Carangidae | Jacks | 1,051 | 52,556 | 1,260 | 62,976 | |
| Scaridae | Parrotfishes | 350 | 17,519 | 5,668 | 283,391 | |
| Tripterygiidae | Triplefin Blennies | 0 | 0 | 945 | 47,232 | |
| Eleotrididae | Sleepers | 0 | 0 | 315 | 15,744 | |
| Gobiidae | Gobies | 11,562 | 578,117 | 16,689 | 834,430 | |
| Hemiramphidae | Half-beaks | 0 | 0 | 1,889 | 94,464 | |
| Anthenaridae | Frogfishes | 1,051 | 52,556 | 315 | 15,744 | |
| Apogonidae | Cardinalfishes | 350 | 17,519 | 0 | 0 | |
| Monacanthidae | Filefishes | 350 | 17,519 | 315 | 15,744 | |
| Pomacentridae | Damselfishes | 350 | 17,519 | 4,093 | 204,671 | |
| Pomacanthidae | Angelfishes | 0 | 0 | 315 | 15,744 | |
| Ostraciidae | Trunkfishes | 0 | 0 | 315 | 15,744 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Sphyraenidae | Barracudas | 2,803 | 140,150 | 945 | 47,232 | |
| Scombridae | Tunas/Mackerels | 350 | 17,519 | 945 | 47,232 | |
| Myctophidae | Myctophids | 0 | 0 | 630 | 31,488 | |
| Pleuronectiformes | Flounders | 0 | 0 | 315 | 15,744 | |
| Coryphaenidae | Dolphinfishes | 350 | 17,519 | 0 | 0 | |
| **Total Post-flexion larvae** | | 50,454 | 2,522,692 | 105,799 | 5,289,969 | **7,812,661** |
| **Pre-flexion Larvae** | | | | | | |
| Nemichthyidae | Snipe eels | 0 | 0 | 315 | 15,744 | |
| Clupeiformes | Sardines/Anchovies | 188,501 | 9,425,058 | 706,904 | 35,345,177 | |
| Clupeidae | Sardines | 0 | 0 | 0 | 0 | |
| Engraulidae | Anchovies | 0 | 0 | 0 | 0 | |
| Atherinidae | Silversides | 350 | 17,519 | 2,519 | 125,952 | |
| Microdesmidae | Wormfishes | 1,051 | 52,556 | 0 | 0 | |
| Berycidae | Redfishes | 0 | 0 | 315 | 15,744 | |
| Gobiesocidae | Clingfishes | 3,153 | 157,668 | 4,408 | 220,415 | |
| Gerreidae | Mojarras | 8,409 | 420,449 | 4,093 | 204,671 | |
| Sciaenidae | Drums and Croakers | 0 | 0 | 630 | 31,488 | |
| Lutjanidae | Snappers | 4,204 | 210,224 | 9,446 | 472,319 | |
| Haemulidae | Grunts | 19,971 | 998,566 | 28,969 | 1,448,444 | |
| Carangidae | Jacks | 4,905 | 245,262 | 6,927 | 346,367 | |
| Tripterigiidae | Triplefin Blennies | 6,307 | 315,337 | 10,076 | 503,807 | |
| Gobiidae | Gobies | 15,066 | 753,304 | 35,581 | 1,779,067 | |
| Pomacentridae | Damselfishes | 39,592 | 1,979,613 | 45,343 | 2,267,129 | |
| Pomacanthidae | Angelfishes | 350 | 17,519 | 315 | 15,744 | |
| Labridae | Wrasses | 10,862 | 543,080 | 11,021 | 551,038 | |
| Opistognathidae | Jawfishes | 1,051 | 52,556 | 315 | 15,744 | |
| Hemiramphidae | Half-beaks | 1,051 | 52,556 | 0 | 0 | |
| Serranidae | Groupers | 701 | 35,037 | 1,260 | 62,976 | |
| Scaridae | Parrotfishes | 350 | 17,519 | 0 | 0 | |
| Scorpaenidae | Scorpionfishes | 0 | 0 | 315 | 15,744 | |
| Sphyraenidae | Barracudas | 6,307 | 315,337 | 4,093 | 204,671 | |
| Scombridae | Tunas/Mackerels | 1,051 | 52,556 | 1,260 | 62,976 | |
| Balistidae | Triggerfishes | 0 | 0 | 315 | 15,744 | |
| Monacanthidae | Filefishes | 0 | 0 | 315 | 15,744 | |
| Tetraodontidae | Porcupinefishes | 350 | 17,519 | 1,260 | 62,976 | |
| Unidentified | | 158,719 | 7,935,969 | 163,107 | 8,155,368 | |
| **Total Pre flexion larvae** | | 472,304 | 23,615,202 | 1,039,101 | 51,955,049 | **75,570,250** |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Decapod/Mollusk/Cephalopod** | | | | | | |
| **Larvae** | | | | | | |
| Section Anomura | Hermit Crabs | 22,424 | 1,121,197 | 13,855 | 692,734 | |
| Section Brachyura | True Crabs | 1,683,196 | 84,159,814 | 1,539,129 | 76,956,448 | |
| Sub-Order Natantia | Shrimps | 8,757,246 | 437,862,278 | 11,967,924 | 598,396,210 | |
| Sub-Order Panilura | Lobsters | 1,401 | 70,075 | 3,149 | 157,440 | |
| Class Gastropoda | Gastropods | 1,341,231 | 67,061,567 | 871,585 | 43,579,265 | |
| Order Teuthoidea | Squids | 37,840 | 10,898,030 | 33,692 | 1,684,603 | |
| **Total Decapod/Mollusk Larvae** | | 11,843,339 | 601,172,960 | 14,429,334 | 721,466,700 | 1,322,639,659 |
| | | | | | | |
| **TOTAL ANNUAL ENTRAINMENT** | **ALL TAXA/LIFESTAGES, DAY & NIGHT COMBINED** | | | | | **1,762,555,119** |

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# Appendix I:

# Background Information of Fishes Known to Occur in the Project Area

## Baseline Information

There are more than 700 fish species that have the potential to occur within the marine waters of Puerto Rico (Froese and Pauly 2012). Occurrence data from FishBase, Reef Environmental Education Foundation (REEF), Jobos Bay National Estuarine Research Reserve (NERR), entrainment surveys at the Aguirre Power Plant, EFH data, and Tetra Tech's ichthyofauna observation survey, were evaluated to determine what fish resources are likely to be present in the project area and potentially subject to entrainment. These data sources provided the baseline information for the ichthyoplankton assessment. It should be noted however, that a limiting factor in identifying the presence of early lifestages from any of these groups is the available scientific information and taxonomic keys. The state of the science does not support species-level identification of egg and larval stages for fish and shellfish found in the project area; many are limited to family-only identifications. Also, a species' life history strategy may preclude its entrainment potential. For example, a number of shark species can be excluded from the list of "potentially entrainable" species because their reproductive strategy (e.g., live birth to fully-formed individuals) does not result in any entrainable lifestages within the water column.

### *Background Review of Fishes Known to Occur in the Project Area*

The fishes within the project area are typical of those found elsewhere in the Caribbean Sea. Many of the reef-associated and pelagic species are important to both commercial and recreational fisheries. The waters surrounding the project area are within the shelf break and outside of the protected waters of the barrier islands/cays that surround Jobos Bay. Habitats include coral reefs, hardbottom, sand, and coral rubble (see Tetra Tech 2012). Given the variety of fish habitats in the project area, and its exposure to both inshore and offshore waters, the fish diversity is high, as would be expected, with several hundred species known to occur (Froese and Pauly 2012). The fishes closest to shore in the project area are those typically associated with Caribbean coral reefs, such as snappers and grunts. Surveys of nearshore waters off Puerto Rico (Whitall et al. 2011; REEF 2012) indicated that the most abundant fishes were parrotfishes, wrasses, butterflyfishes, surgeonfishes, damselfishes, and grunts.

The distribution of ichthyoplankton is temporally and spatially variable and determined by the habitats, location in the water column, seasons, and even time of day associated with spawning. The coastal waters are typically dominated by estuarine-dependent species, while continental shelf areas are dominated by neritic species. Currents and tides are important factors in the transport of larvae in the immediate vicinity of estuaries and inlets (Epifanio and Garvine 2001), such as the project area located just offshore of Boca del Inferno. Wind, buoyancy, and the influences of oceanic water masses or currents are the principle agents driving the transport of ichthyoplankton in neritic areas (Epifanio and Garvine 2001). Transient spawners, such as seabasses and snappers, move into and out of the spawning area, often coming from great distances over long periods of time. Resident spawners, such as parrotfishes, wrasses, and surgeonfishes, often spawn within or close to their home range (Domeier and Colin 1997). Some coral reef fishes are known for their spawning aggregations, in which concentrations of individuals during reproductive periods are higher than during non-reproductive periods (Domeier and Colin 1997).

Pelagic fish species (e.g., tuna/mackerel, billfishes, flying fish) typically spend their entire lives in neritic and offshore waters. Some species may be associated with particular portions of the water column, other species are capable of utilizing large portions of the water column, and yet others use different portions of the water column during various stages of their life history; such as during feeding or spawning along ocean fronts (Govoni and Hare 2001). Ocean currents aid in transporting pelagic eggs and larvae (Epifanio and Garvine 2001). Sargassum mats, common in the project area, attract some species of pelagic fishes where fish aggregations are common (Moser et al. 1998).

Table A-1 presents the fish species that are known to occur in the marine waters of the south coast of Puerto Rico, based on the data sources indicated.

**Table A-1: Inventory of Fish Species Known to Occur Near the Project Area (regionally and locally) and Those Taxa Observed During the 2012 Tetra Tech (Tt) Dive Survey and 2012 Tetra Tech (Tt) Ichthyoplankton Survey (This Study)**

| Family | Species | Common Name | Regional | | Local | | Site-Specific (Project Area) | |
|---|---|---|---|---|---|---|---|---|
| | | | reef.org [1] | EFH Species[2] | Jobos Bay NERR [3] | Aguirre Power Plant | Tt Dive Survey | Tt Ichthyo Survey |
| | *Acanthurus bahianus* | Ocean surgeon | X | X | X | | X | |
| Acanthuridae | *Acanthurus chirurgus* | Doctorfish | X | X | X | | X | |
| | *Acanthurus coeruleus* | Blue tang surgeonfish | X | X | X | | X | |
| | *Antennarius multiocellatus* | Longlure frogfish | | | | | | |
| | *Antennarius pauciradiatus* | Dwarf frogfish | | | | | | |
| | *Antennarius spp.* | Frogfishes | | X | | | | |
| Antennariidae | *Antennarius striatus* | Striated frogfish | | | | | | X |
| | *Antennatus bermudensis* | Island frogfish | | | | | | |
| | *Fowlerichthys ocellatus* | Ocellated frogfish | | | | | | |
| | *Histrio histrio* | Sargassumfish | | | | | | |
| | *Apogon binotatus* | Barred cardinalfish | X | | X | | | |
| | *Apogon lachneri* | Whitestar cardinalfish | X | | | | | |
| | *Apogon maculatus* | Flamefish | X | X | | | X | |
| | *Apogon pseudomaculatus* | Twospot cardinalfish | X | | | | | |
| Apogonidae | *Apogon quadrisquamatus* | Sawcheek cardinalfish | X | | | | | X |
| | *Apogon robinsi* | Roughlip cardinalfish | X | | | | | |
| | *Apogon townsendi* | Belted cardinalfish | X | | | | | |
| | *Astrapogon stellatus* | Conchfish | | X | | | | |
| | *Phaeoptyx xenus* | Sponge cardinalfish | X | | | | | |
| Atherinidae [4] | | silversides | | | | | | X |
| Aulostomidae | *Aulostomus maculatus* | Trumpetfish | X | X | | | X | |
| | *Balistes capriscus* | Grey triggerfish | | | | | | |
| | *Balistes vetula* | Queen triggerfish | X | X | X | | X | |
| Balistidae | *Canthidermis sufflamen* | -- | X | X | | | | X |
| | *Melichthys niger* | Black triggerfish | X | X | | | | |
| | *Xanthichthys ringens* | Sargassum triggerfish | X | X | | | | |
| Belonidae | *Ablennes hians* | Flat needlefish | X | | | | | |
| | *Strongylura marina* | Atlantic needlefish | X | | | | | |
| Berycidae [4] | | Redfishes/Alfonsinos | | | | | | X |
| | *Entomacrodus nigricans* | Pearl blenny | X | | | | | |
| Blenniidae | *Ophioblennius atlanticus* | -- | X | X | | | | |
| | *Ophioblennius macclurei* | Redlip blenny | | | X | | | |
| Bothidae | *Bothus lunatus* | Plate fish | X | X | | | | |
| | *Bothus ocellatus* | Eyed flounder | X | | | | X | |
| Bythidae [4] | | Brotulas | | | | | | X |
| | *Callionymus bairdi* | Lancer dragonet | | | | | | |
| Callionymidae | *Diplogrammus pauciradiatus* | Spotted dragonet | | | | | | X |
| | *Foetorepus agassizii* | Spotfin dragonet | | | | | | |
| | *Alectis ciliaris* | African pompano | | | | | | |
| | *Carangoides bartholomaei* | Yellow jack | X | X | | | | |
| | *Carangoides ruber* | Bar jack | | | X | | | |
| | *Caranx crysos* | Blue runner | X | X | X | | X | |
| | *Caranx hippos* | Crevalle jack | | | | | | |
| | *Caranx latus* | Horse-eye jack | X | X | | | | |
| | *Caranx lugubris* | Black jack | X | X | | | | |
| | *Caranx ruber* | Bar jack | X | X | | | X | |
| | *Chloroscombrus chrysurus* | Atlantic bumper | X | | | | | |
| | *Decapterus macarellus* | Mackerel scad | X | | | | | |
| | *Decapterus punctatus* | Round scad | | | | | | |
| Carangidae | *Decapterus tabl* | Roughear scad | X | | | X | | X |
| | *Elagatis bipinnulata* | Rainbow runner | X | | | | | |
| | *Naucrates ductor* | Pilotfish | | | | | | |
| | *Oligoplites saurus* | Leatherjacket | X | | | | | |
| | *Selar crumenophthalmus* | Bigeye scad | X | | | | | |
| | *Selene brownii* | Caribbean moonfish | | | | | | |
| | *Selene setapinnis* | Atlantic moonfish | | | | | | |
| | *Selene spixii* | Caribbean moonfish | | | | | | |
| | *Selene vomer* | Lookdown | | | | | | |
| | *Seriola dumerili* | Greater amberjack | | X | | | | |
| | *Seriola rivoliana* | Longfin yellowtail | | X | | | | |
| | *Trachinotus carolinus* | Florida pompano | | | | | | |

[1] REEF 2012
[2] All EFH information obtained from the National Marine Fisheries Service's (NMFS) EFH Mapping Tool, located at http://www.habitat.noaa.gov/protection/efh/habitatmapper.html
[3] Whitall et al. 2011
[4] Family not previously accounted for in the Project Area

| Family | Species | Common Name | Regional | | Local | | Site-Specific (Project Area) | |
|---|---|---|---|---|---|---|---|---|
| | | | reef.org [1] | EFH Species[2] | Jobos Bay NERR [3] | Aguirre Power Plant | Tt Dive Survey | Tt Ichthyo Survey |
| | *Trachinotus falcatus* | Permit | | | | | | |
| | *Trachinotus goodei* | Great pompano | X | | | | | |
| | *Uraspis secunda* | Cottonmouth jack | | | | | | |
| Carcharhinidae | *Galeocerdo cuvier* | Tiger shark | | X | | | | |
| | *Negaprion brevirostris* | Lemon shark | | X | | | | |
| Centropomidae | *Centropomus undecimalis* | Common snook | | | X | | | |
| Chaenopsidae | *Acanthemblemaria aspera* | Roughhead blenny | X | | | | | |
| | *Acanthemblemaria maria* | Secretary blenny | X | | | | | |
| | *Acanthemblemaria spinosa* | Spinyhead blenny | X | | | | | |
| | *Chaenopsis limbaughi* | Yellowface pikeblenny | X | | | | | |
| | *Chaenopsis ocellata* | Bluethroat pikeblenny | X | | | | | |
| | *Emblemaria pandionis* | Sailfin blenny | X | | | | | |
| | *Emblemaria piratula* | Pirate blenny | X | | | | | |
| | *Emblemariopsis spp.* | Blennies | X | | | | | |
| | *Lucayablennius zingaro* | Arrow blenny | X | | | | | |
| Chaetodontidae | *Chaetodon aculeatus* | Longsnout butterflyfish | X | X | | | | |
| | *Chaetodon capistratus* | Foureye butterflyfish | X | X | X | | X | |
| | *Chaetodon ocellatus* | Spotfin butterflyfish | X | X | | | | |
| | *Chaetodon sedentarius* | Reef butterflyfish | X | | X | | | |
| | *Chaetodon striatus* | Banded butterflyfish | X | X | X | | X | |
| Cirrhitidae | *Amblycirrhitus pinos* | Redspotted hawkfish | X | X | | | X | |
| Clupeidae | *Chirocentrodon bleekerianus* | Dogtooth herring | | | | | | |
| | *Harengula clupeola* | False herring | | | | | | |
| | *Harengula humeralis* | Redear herring | | | | | | |
| | *Harengula jaguana* | Scaled herring | | | | | | |
| | *Jenkinsia lamprotaenia* | Dwarf round herring | | | | | | |
| | *Jenkinsia sp.* | Herrings | | | X | X | | X |
| | *Jenkinsia stolifera* | Florida round herring | | | | | | |
| | *Opisthonema oglinum* | Atlantic thread herring | | | | | | |
| | *Sardinella aurita* | Round sardinella | | | | | | |
| | *Sardinella brasiliensis* | Brazilian sardinella | | | | | | |
| Congridae | *Heteroconger longissimus* | Brown garden eel | X | | | | | |
| Coryphaenidae [5] | | Dolphinfishes | X | X | | | | X |
| Cynoglossidae | *Symphurus arawak* | Caribbean tonguefish | | X | | | | |
| Dasyatidae | *Dasyatis americana* | Southern stingray | X | | X | | | |
| Dactylopteridae | *Dactylopterus volitans* | Flying gurnard | | X | | | | |
| Diodontidae | *Diodon holocanthus* | Longspined porcupinefish | X | | | | | |
| | *Diodon hystrix* | Spot-fin porcupinefish | X | X | | | | |
| Echeneidae | *Echeneis naucrates* | Live sharksucker | X | | | | | |
| Eleotrididae [5] | | sleepers | | | | | | X |
| Engraulidae | *Anchoa cayorum* | Key anchovy | | | | | | |
| | *Anchoa colonensis* | Narrow-striped anchovy | | | | | | |
| | *Anchoa cubana* | Cuban anchovy | | | | | | |
| | *Anchoa filifera* | Longfinger anchovy | | | | | | |
| | *Anchoa hepsetus* | Broad-striped anchovy | | | | | | |
| | *Anchoa lamprotaenia* | Big-eye anchovy | | | | X | | X |
| | *Anchoa lyolepis* | Shortfinger anchovy | | | | | | |
| | *Anchoa parva* | Little anchovy | | | | | | |
| | *Anchovia clupeoides* | Zabaleta anchovy | | | | | | |
| | *Anchoviella perfasciata* | Poey's anchovy | | | | | | |
| | *Cetengraulis edentulus* | Atlantic anchoveta | | | | | | |
| Ephippidae | *Chaetodipterus faber* | Atlantic spadefish | X | X | | | | X |
| Exocoetidae [5] | | flyingfishes | | | | | | X |
| Gerreidae | *Diapterus auratus* | Irish mojarra | | | | | | |
| | *Diapterus rhombeus* | Caitipa mojarra | | | | | | |
| | *Eucinostomus argenteus* | Silver mojarra | | | | | | |
| | *Eucinostomus gula* | Jenny mojarra | X | | | X | | |
| | *Eucinostomus havana* | Bigeye mojarra | | | | | | |
| | *Eucinostomus jonesii* | Slender mojarra | | | | | | X |
| | *Eucinostomus lefroyi* | Mottled mojarra | X | | | | | |
| | *Eucinostomus melanopterus* | Flagfin mojarra | | | | | | |
| | *Eugerres brasilianus* | Brazilian mojarra | | | | | | |
| | *Eugerres plumieri* | Striped mojarra | | | | | | |
| | *Gerres cinereus* | Yellow fin mojarra | X | | X | | X | |
| Ginglymostomatida | *Ginglymostoma cirratum* | Nurse shark | X | | | | X | |
| Gobiesocidae | *Acyrtus artius* | Papillate clingfish | | | | | | X |
| | *Acyrtus rubiginosus* | Red clingfish | | | | | | |

[5] Family not previously accounted for in the Project Area

| Family | Species | Common Name | Regional | | Local | | Site-Specific (Project Area) | |
|---|---|---|---|---|---|---|---|---|
| | | | reef.org [1] | EFH Species[2] | Jobos Bay NERR [3] | Aguirre Power Plant | Tt Dive Survey | Tt Ichthyo Survey |
| | *Arcos macrophthalmus* | Padded clingfish | | | | | | |
| | *Gobiesox nigripinnis* | Blackfinned clingfish | | | | | | |
| | *Gobiesox nudus* | Clingfish | | | | | | |
| | *Gobiesox punctulatus* | Stippled clingfish | | | | | | |
| | *Gobiesox strumosus* | Skilletfish | | | | | | |
| | *Tomicodon cryptus* | -- | | | | | | |
| | *Tomicodon fasciatus* | Barred clingfish | | | | | | |
| | *Tomicodon reitzae* | -- | | | | | | |
| | *Tomicodon rupestris* | -- | | | | | | |
| | *Barbulifer antennatus* | Barbulifer | | | | | | |
| | *Barbulifer ceuthoecus* | Bearded goby | | | | | | |
| | *Bathygobius antilliensis* | Antilles frillfin | | | | | | |
| | *Bathygobius curacao* | Notchtongue goby | | | | | | |
| | *Bathygobius geminatus* | Twin-spotted frillfin | | | | | | |
| | *Bathygobius mystacium* | Island frillfin | | | | | | |
| | *Bathygobius soporator* | Frillfin goby | | | | | | |
| | *Bollmannia boqueronensis* | White-eye goby | X | | | | | |
| | *Bollmannia communis* | Ragged goby | | | | | | |
| | *Chriolepis fisheri* | Translucent goby | | | | | | |
| | *Coryphopterus dicrus* | Colon goby | X | | | | | |
| | *Coryphopterus eidolon* | Pallid goby | X | | | | | |
| | *Coryphopterus glaucofraenum* | Bridled goby | X | | X | | | |
| | *Coryphopterus lipernes* | Peppermint goby | X | | | | | |
| | *Coryphopterus personatus* | Masked goby | X | | X | | X | |
| | *Coryphopterus tortugae* | Patch-reef goby | | | | | | |
| | *Coryphopterus venezuelae* | -- | | | | | | |
| | *Ctenogobius boleosoma* | Darter goby | | | | | | |
| | *Ctenogobius claytonii* | Mexican goby | | | | | | |
| | *Ctenogobius saepepallens* | Dash goby | | | X | | | |
| | *Ctenogobius stigmaturus* | Spottail goby | | | | | | |
| | *Elacatinus chancei* | Shortstripe goby | | | | | | |
| | *Elacatinus dilepis* | Orangesided goby | | | | | | |
| | *Elacatinus evelynae* | Sharknose goby | | | X | | | |
| | *Elacatinus gemmatus* | Frecklefin goby | | | X | | | |
| | *Elacatinus genie* | Cleaner goby | | | | | | |
| | *Elacatinus multifasciatus* | Greenbanded goby | | | X | | | |
| | *Elacatinus pallens* | Semiscaled goby | | | | | | |
| | *Elacatinus prochilos* | Broadstripe goby | | | | | | |
| | *Elacatinus randalli* | Yellownose goby | | | | | | |
| Gobiidae | *Elacatinus tenox* | Slaty goby | | | | X | | X |
| | *Evermannichthys metzelaari* | Sponge goby | | | | | | |
| | *Evorthodus lyricus* | Lyre goby | | | | | | |
| | *Garmannia saucra* | Leopard goby | X | | | | | |
| | *Ginsburgellus novemlineatus* | Nineline goby | | | | | | |
| | *Gnatholepis thompsoni* | Goldspot goby | X | | X | | | |
| | *Gobioides broussonnetii* | Violet goby | | | | | | |
| | *Gobionellus saepepallens* | Dash goby | X | | | | | |
| | *Gobionellus stigmalophius* | Spotfin goby | X | | | | | |
| | *Gobiosoma chancei* | Shortstripe goby | X | | | | | |
| | *Gobiosoma evelynae* | Sharknose goby | X | | | | X | |
| | *Gobiosoma genie* | Cleaner goby | X | | | | | |
| | *Gobiosoma horsti* | Yellowline goby | X | | | | | |
| | *Gobiosoma oceanops* | Neon goby | | X | | | | |
| | *Gobiosoma pallens* | Semiscaled goby | X | | | | | |
| | *Gobiosoma randalli* | Yellownose goby | X | | | | | |
| | *Gobiosoma spes* | Vermiculated goby | | | | | | |
| | *Lophogobius cyprinoides* | Crested goby | X | | X | | | |
| | *Lythrypnus crocodilus* | Mahogany goby | | | | | | |
| | *Lythrypnus nesiotes* | Island goby | | | | | | |
| | *Lythrypnus spilus* | Bluegold goby | | | | | | |
| | *Microgobius meeki* | -- | | | | | | |
| | *Microgobius signatus* | -- | | | | | | |
| | *Microgobius sp.* | -- | | | X | | | |
| | *Nes longus* | Orangespotted goby | X | | X | | | |
| | *Oxyurichthys stigmalophius* | Spotfin goby | | | X | | | |
| | *Parrella macropteryx* | -- | | | | | | |
| | *Priolepis hipoliti* | Rusty goby | X | X | | | | |
| | *Psilotris alepis* | Scaleless goby | | | | | | |
| | *Psilotris batrachodes* | Toadfish goby | | | | | | |
| | *Psilotris celsa* | Highspine goby | | | | | | |

| Family | Species | Common Name | Regional | | Local | | Site-Specific (Project Area) | |
|---|---|---|---|---|---|---|---|---|
| | | | reef.org [1] | EFH Species[2] | Jobos Bay NERR [3] | Aguirre Power Plant | Tt Dive Survey | Tt Ichthyo Survey |
| | *Pycnomma roosevelti* | Roosevelt's goby | | | | | | |
| | *Risor ruber* | Tusked goby | X | | | | | |
| | *Sicydium plumieri* | Sirajo | | | | | | |
| | *Sicydium punctatum* | -- | | | | | | |
| | *Varicus bucca* | -- | | | | | | |
| Grammatidae | *Gramma loreto* | Royal gramma | X | X | X | | | |
| | *Anisotremus surinamensis* | Black margate | X | | | | | |
| | *Anisotremus virginicus* | Porkfish | X | X | X | | X | |
| | *Conodon nobilis* | Barred grunt | | | | | | |
| | *Haemulon album* | White margate | | X | | | | |
| | *Haemulon aurolineatum* | Tomtate grunt | X | X | X | | X | |
| | *Haemulon bonariense* | Black grunt | | | | | | |
| | *Haemulon carbonarium* | Caesar grunt | X | | X | | | |
| | *Haemulon chrysargyreum* | Smallmouth grunt | X | | | | X | |
| | *Haemulon flavolineatum* | French grunt | X | X | X | | X | |
| Haemulidae | *Haemulon macrostomum* | Spanish grunt | X | | X | X | X | X |
| | *Haemulon melanurum* | Cottonwick grunt | | | | | | |
| | *Haemulon parra* | Sailor's grunt | X | | | | | |
| | *Haemulon plumierii* | White grunt | X | X | X | | X | |
| | *Haemulon sciurus* | Bluestriped grunt | X | X | X | | X | |
| | *Haemulon sp.* | Grunts | | | X | | | |
| | *Haemulon striatum* | Striped grunt | | | | | X | |
| | *Haemulon vittata* | Boga | | | | | | |
| | *Pomadasys corvinaeformis* | Roughneck grunt | | | | | | |
| | *Pomadasys crocro* | Burro grunt | | | | | | |
| | *Euleptorhamphus velox* | Flying halfbeak | | | | | | |
| Hemiramphidae | *Hemiramphus balao* | Balao halfbeak | | | | | | X |
| | *Hemiramphus brasiliensis* | Ballyhoo halfbeak | | | | | | |
| | *Hyporhamphus unifasciatus* | Common halfbeak | | | | | | |
| | *Holocentrus adscensionis* | Squirrelfish | X | X | X | | X | |
| | *Holocentrus rufus* | Longspine squirrelfish | X | X | X | | X | |
| | *Myripristis jacobus* | Blackbar soldierfish | X | X | X | | X | |
| Holocentridae | *Neoniphon marianus* | Longjaw squirrelfish | X | | | | | |
| | *Plectrypops retrospinis* | Cardinal soldierfish | X | X | | | | |
| | *Sargocentron coruscum* | Reef squirrelfish | | | X | | | |
| | *Sargocentron vexillarium* | Dusky squirrelfish | X | | | | X | |
| Inermiidae | *Inermia vittata* | Boga | X | | | | | |
| Istiophoridae | *Istiophorus albicans* | Atlantic sailfish | | X | | | | |
| | *Tetrapturus pfluegeri* | Longbill spearfish | | X | | | | |
| Kyphosidae | *Kyphosus incisor* | Yellow sea chub | | | X | | | |
| | *Kyphosus sectatrix* | Bermuda sea chub | X | | | | | |
| | *Bodianus pulchellus* | Spotfin hogfish | | | | | | |
| | *Bodianus rufus* | Spanish hogfish | X | X | X | | X | |
| | *Clepticus parrae* | Creole wrasse | X | X | | | | |
| | *Decodon puellaris* | Red hogfish | | | | | | |
| | *Doratonotus megalepis* | Dwarf wrasse | X | | | | | |
| | *Halichoeres bivittatus* | Slippery dick | X | | X | | X | |
| | *Halichoeres caudalis* | Painted wrasse | | | | | | |
| | *Halichoeres cyanocephalus* | Yellowcheek wrasse | X | X | | | | |
| | *Halichoeres garnoti* | Yellowhead wrasse | X | X | X | | X | |
| | *Halichoeres maculipinna* | Clown wrasse | X | X | X | | X | |
| Labridae | *Halichoeres pictus* | Rainbow wrasse | X | | X | | | X |
| | *Halichoeres poeyi* | Blackear wrasse | X | | X | | X | |
| | *Halichoeres radiatus* | Puddingwife wrasse | X | X | X | | X | |
| | *Hemipteronotus novacula* | Pearly razorfish | | X | | | | |
| | *Hemipteronotus splendens* | Green razorfish | | X | | | | |
| | *Lachnolaimus maximus* | Hogfish | X | X | X | | X | |
| | *Thalassoma bifasciatum* | Bluehead | X | X | X | | X | |
| | *Xyrichtys martinicensis* | Rosy razorfish | X | | X | | | |
| | *Xyrichtys novacula* | Pearly razorfish | | | | | | |
| | *Xyrichtys splendens* | Green razorfish | X | | X | | | |
| | *Labrisomus kalisherae* | Downy blenny | X | | | | | |
| | *Labrisomus nuchipinnis* | Hairy blenny | X | | | | | |
| | *Malacoctenus aurolineatus* | Goldline blenny | X | | | | | |
| Labrisomidae | *Malacoctenus boehlkei* | Diamond blenny | X | | | | | |
| | *Malacoctenus gilli* | Dusky blenny | X | | | | | |
| | *Malacoctenus macropus* | Rosy blenny | X | | X | | | |
| | *Malacoctenus triangulatus* | Saddled blenny | X | | X | | X | |
| Labrisomidae | *Malacoctenus versicolor* | Barfin blenny | X | | | | | |
| Lutjanidae | *Apsilus dentatus* | Black snapper | | X | | | | X |

| Family | Species | Common Name | Regional | | Local | | Site-Specific (Project Area) | |
|---|---|---|---|---|---|---|---|---|
| | | | reef.org [1] | EFH Species[2] | Jobos Bay NERR [3] | Aguirre Power Plant | Tt Dive Survey | Tt Ichthyo Survey |
| | *Etelis oculatus* | Queen snapper | | X | | | | |
| | *Lutjanus analis* | Mutton snapper | X | X | X | | | |
| | *Lutjanus apodus* | Schoolmaster snapper | X | X | X | | X | |
| | *Lutjanus buccanella* | Blackfin snapper | | X | | | | |
| | *Lutjanus cyanopterus* | Cubera snapper | X | | | | | |
| | *Lutjanus griseus* | Grey snapper | X | X | X | | X | |
| | *Lutjanus jocu* | Dog snapper | X | X | X | | | |
| | *Lutjanus mahogoni* | Mahogany snapper | X | X | X | | | |
| | *Lutjanus purpureus* | Southern red snapper | | | | | | |
| | *Lutjanus sp.* | Snappers | | | X | | | |
| | *Lutjanus synagris* | Lane snapper | X | X | X | | X | |
| | *Lutjanus vivanus* | Silk snapper | | X | | | | |
| | *Ocyurus chrysurus* | Yellowtail snapper | X | X | X | | X | |
| | *Pristipomoides aquilonaris* | Wenchman | | X | | | | |
| | *Pristipomoides* | Cardinal snapper | | | | | | |
| | *Rhomboplites aurorubens* | Vermilion snapper | | X | | | | |
| Malacanthidae | *Caulolatilus chrysops* | Atlantic goldeneye tilefish | | X | | | | |
| | *Malacanthus plumieri* | Sand tilefish | X | X | | | | |
| Microdesmidae | *Cerdale floridana* | Pugjaw wormfish | | | | | | X |
| | *Microdesmus luscus* | Blind wormfish | | | | | | |
| Monacanthidae | *Aluterus schoepfii* | Orange filefish | | | | | | X |
| | *Aluterus scriptus* | Scribbled leatherjacket | X | X | | | | |
| | *Cantherhines macrocerus* | American whitespotted | X | X | X | | | |
| | *Cantherhines pullus* | Orangespotted filefish | X | | X | | X | |
| | *Monacanthus ciliatus* | Fringed filefish | | | | | | |
| | *Monacanthus tuckeri* | Slender filefish | X | | | | | |
| | *Stephanolepis hispidus* | Planehead filefish | | | | | | |
| | *Stephanolepis setifer* | Pygmy filefish | | | | | | |
| Mugilidae | *Mugil cephalus* | Flathead grey mullet | | | | X | | X |
| | *Mugil curema* | White mullet | | | | | | |
| | *Mugil curvidens* | Dwarf mullet | | | | | | |
| | *Mugil gyrans* | Fantail mullet | | | | | | |
| | *Mugil liza* | Lebranche mullet | | | | | | |
| | *Mugil trichodon* | -- | | | | | | |
| Mullidae | *Mulloidichthys martinicus* | Yellow goatfish | X | X | X | | | |
| | *Pseudupeneus maculatus* | Spotted goatfish | X | | X | | X | |
| Muraenidae | *Echidna catenata* | Chain moray | X | X | | | | |
| | *Enchelycore carychroa* | Caribbean chestnut moray | X | | | | | |
| | *Gymnothorax funebris* | Green moray | X | X | | | | |
| | *Gymnothorax miliaris* | Goldentail moray | X | X | | | | |
| | *Gymnothorax moringa* | Spotted moray | X | | X | | X | |
| | *Gymnothorax vicinus* | Purplemouth moray | X | | | | | |
| Myctophidae | | lanternfishes | | | | | | X |
| Nemichthyidae [6] | | Snipe eels | | | | | | X |
| Nomeidae | *Psenes maculatus* | Silver driftfish | | X | | | | |
| Ophichthidae | *Myrichthys breviceps* | Sharptail eel | X | | | | | |
| | *Myrichthys ocellatus* | Goldspotted eel | | X | | | | |
| | *Synodus saurus* | Atlantic lizardfish | X | | | | | |
| Ogcocephalidae | *Ogcocepahalus spp.* | -- | | X | | | | |
| Ophidiidae | *Brotula barbata* | Bearded brotula | | | | | | X |
| | *Lamprogrammus brunswigi* | | | | | | | |
| | *Lepophidium pheromystax* | Blackedge cusk-eel | | | | | | |
| | *Lepophidium profundorum* | Blackrim cusk-eel | | | | | | |
| | *Neobythites elongatus* | -- | | | | | | |
| | *Neobythites marginatus* | Stripefin brotula | | | | | | |
| | *Neobythites ocellatus* | -- | | | | | | |
| | *Neobythites unicolor* | -- | | | | | | |
| | *Ophidion holbrookii* | Band cusk-eel | | | | | | |
| | *Ophidion lagochila* | Harelip cusk | | | | | | |
| | *Ophidion nocomis* | Letter opener | | | | | | |
| | *Parophidion schmidti* | Dusky cusk-eel | | | | | | |
| | *Petrotyx sanguineus* | Redfin brotula | | | | | | |
| Opistognathidae | *Opistognathus aurifrons* | Yellowhead jawfish | X | X | X | | X | X |
| | *Opistognathus whitehursti* | Dusky jawfish | X | X | | | | |
| Ostraciidae | *Lactophrys bicaudalis* | Spotted trunkfish | X | X | | | | X |
| | *Lactophrys polygonius* | Honeycomb cowfish | X | X | | | | |
| | *Lactophrys quadricornis* | Scrawled cowfish | X | X | | | | |

[6] Family not previously accounted for in the Project Area

| Family | Species | Common Name | Regional | | Local | | Site-Specific (Project Area) | |
|---|---|---|---|---|---|---|---|---|
| | | | reef.org [1] | EFH Species[2] | Jobos Bay NERR [3] | Aguirre Power Plant | Tt Dive Survey | Tt Ichthyo Survey |
| | *Lactophrys trigonus* | Buffalo trunkfish | | X | | | | |
| | *Lactophrys triqueter* | Smooth trunkfish | X | X | | | | |
| Pempheridae | *Pempheris schomburgkii* | Glassy sweeper | X | | | | X | |
| Pleuronectiformes [7] | | Right-eye flounders | | | | | | X |
| Pomacanthidae | *Centropyge argi* | Cherubfish | | X | | | | X |
| | *Holacanthus ciliaris* | Queen angelfish | X | X | | | | |
| | *Holacanthus tricolor* | Rock beauty | X | X | X | | | |
| | *Pomacanthus arcuatus* | Gray angelfish | X | X | X | | | |
| | *Pomacanthus imperator* | Emperor angelfish | | | | | | |
| | *Pomacanthus paru* | French angelfish | X | X | X | | X | |
| | *Pomacentrus fuscus* | Brazilian damsel | | X | | | | |
| | *Pomacentrus leucostictus* | Beaugregory | | X | | | | |
| | *Pomacentrus partitus* | Bicolor damselfish | | X | | | | |
| | *Pomacentrus planifrons* | Threespot damselfish | | X | | | | |
| Pomacentridae | *Abudefduf saxatilis* | Sergeant-major | X | X | X | | X | X |
| | *Abudefduf taurus* | Night sergeant | X | | | | | |
| | *Chromis cyanea* | Blue chromis | X | X | X | | | |
| | *Chromis enchrysura* | Yellowtail reeffish | | | | | | |
| | *Chromis insolata* | Sunshinefish | X | X | | | | |
| | *Chromis multilineata* | Brown chromis | X | | | | | |
| | *Chromis scotti* | Purple reeffish | | | | | | |
| | *Microspathodon chrysurus* | Yellowtail damselfish | X | X | X | | X | |
| | *Stegastes adustus* | Dusky damselfish | X | | X | | | |
| | *Stegastes diencaeus* | Longfin damselfish | X | | X | | X | |
| | *Stegastes leucostictus* | Beaugregory | X | | X | | X | |
| | *Stegastes partitus* | Bicolor damselfish | X | | X | | X | |
| | *Stegastes planifrons* | Threespot damselfish | X | | X | | X | |
| | *Stegastes spp.* | Damselfishes | | | | | X | |
| | *Stegastes variabilis* | Cocoa damselfish | X | | X | | X | |
| Priacanthidae | *Heteropriacanthus cruentatus* | Glasseye snapper | X | X | X | | X | |
| | *Priacanthus arenatus* | Atlantic bigeye | X | X | | | | |
| Ptereleotridae | *Ptereleotris calliurus* | Blue goby | X | | | | | |
| | *Ptereleotris helenae* | Hovering goby | X | | X | | X | |
| Rachycentridae | *Rachycentron canadum* | Cobia | | | | | | |
| Scaridae | *Cryptotomus roseus* | Bluelip parrotfish | X | | X | | | X |
| | *Scarus coelestinus* | Midnight parrotfish | X | X | | | | |
| | *Scarus coeruleus* | Blue parrotfish | | X | | | | |
| | *Scarus croicensis* | Striped parrotfish | | X | | | | |
| | *Scarus guacamaia* | Rainbow parrotfish | X | X | | | | |
| | *Scarus iseri* | Striped parrotfish | X | | X | | X | |
| | *Scarus taeniopterus* | Princess parrotfish | X | X | X | | X | |
| | *Scarus vetula* | Queen parrotfish | X | X | | | | |
| | *Sparisoma atomarium* | Greenblotch parrotfish | X | | X | | | |
| | *Sparisoma aurofrenatum* | Redband parrotfish | X | X | X | | X | |
| | *Sparisoma chrysopterum* | Redtail parrotfish | X | X | | | | |
| | *Sparisoma radians* | Bucktooth parrotfish | X | | X | | | |
| | *Sparisoma rubripinne* | Redfin parrotfish | X | X | X | | X | |
| | *Sparisoma sp.* | Parrotfishes | | | X | | | |
| | *Sparisoma viride* | Stoplight parrotfish | X | X | X | | X | |
| Sciaenidae | *Equetus acuminatus* | High-hat | X | X | | | | X |
| | *Equetus lanceolatus* | Jack-knifefish | | X | | | | |
| | *Equetus punctatus* | Spotted drum | X | X | | | X | |
| | *Odontoscion dentex* | Reef croaker | X | | | | X | |
| Scombridae | *Acanthocybium solandri* | Wahoo | | | | | | X |
| | *Auxis rochei rochei* | Bullet tuna | | | | | | |
| | *Auxis thazard thazard* | Frigate tuna | | | | | | |
| | *Euthynnus alletteratus* | Little tunny | | | | | | |
| | *Katsuwonus pelamis* | Skipjack tuna | | | | | | |
| | *Sarda sarda* | Atlantic bonito | | | | | | |
| | *Scomberomorus cavalla* | King mackerel | X | | | | | |
| | *Scomberomorus maculatus* | Atlantic Spanish mackerel | X | | | | | |
| | *Scomberomorus regalis* | Cero | X | | X | | X | |
| | *Thunnus alalunga* | Albacore | | | | | | |
| | *Thunnus albacares* | Yellowfin tuna | | | | | | |
| | *Thunnus atlanticus* | Blackfin tuna | | | | | | |
| | *Thunnus obesus* | Bigeye tuna | | | | | | |
| | *Thunnus thynnus* | Atlantic bluefin tuna [8] | | | | | | |

[7] Family not previously accounted for in the Project Area
[8] NMFS Species of Concern

| Family | Species | Common Name | Regional | | Local | | Site-Specific (Project Area) | |
|---|---|---|---|---|---|---|---|---|
| | | | reef.org [1] | EFH Species[2] | Jobos Bay NERR [3] | Aguirre Power Plant | Tt Dive Survey | Tt Ichthyo Survey |
| | *Neomerinthe beanorum* | -- | | | | | | |
| | *Pontinus castor* | Longsnout scorpionfish | | | | | | |
| | *Pontinus nematophthalmus* | Spinythroat scorpionfish | | | | | | |
| | *Pterois miles* | Devil firefish | | | | | | |
| | *Pterois volitans* | Red lionfish [9] | | | | | X | |
| | *Scorpaena albifimbria* | Coral scorpionfish | | | | | | |
| Scorpaenidae | *Scorpaena bergii* | Goosehead scorpionfish | | | | | | X |
| | *Scorpaena brasiliensis* | Barbfish | | | | | | |
| | *Scorpaena elachys* | Dwarf scorpionfish | | | | | | |
| | *Scorpaena grandicornis* | Plumed scorpionfish | | | | | | |
| | *Scorpaena inermis* | Mushroom scorpionfish | | | | | | |
| | *Scorpaena plumieri* | Pacific spotted scorpionfish | X | | X | | | |
| | *Scorpaenodes caribbaeus* | Reef scorpionfish | | | | | | |
| | *Alphestes afer* | Mutton hamlet | | | | | | |
| | *Anthias tenuis* | Threadnose bass | | | | | | |
| | *Bullisichthys caribbaeus* | Pugnose bass | | | | | | |
| | *Cephalopholis cruentata* | Graysby | X | X | X | | | |
| | *Cephalopholis fulva* | Coney | X | | X | | | |
| | *Dermatolepis inermis* | Marbled grouper | | | | | | |
| | *Diplectrum bivittatum* | Dwarf sand perch | | | | | | |
| | *Diplectrum formosum* | Sand perch | X | | | | | |
| | *Diplectrum radiale* | Pond perch | | | | | | |
| | *Epinephelus adscensionis* | Rock hind | X | X | | | | |
| | *Epinephelus flavolimbatus* | Yellowedge grouper | | X | | | | |
| | *Epinephelus fulvus* | Coney | | X | | | | |
| | *Epinephelus guttatus* | Red hind | X | X | | | X | |
| | *Epinephelus itajara* | Atlantic goliath grouper | | X | | | | |
| | *Epinephelus morio* | Red grouper | | X | | | | |
| | *Epinephelus mystacinus* | Misty grouper | | X | | | | |
| | *Epinephelus striatus* | Nassau grouper [10] | X | X | | | | |
| | *Gonioplectrus hispanus* | Spanish flag | | | | | | |
| | *Hemanthias aureorubens* | Streamer bass | | | | | | |
| | *Hypoplectrus aberrans* | Yellowbelly hamlet | X | | | | | |
| | *Hypoplectrus chlorurus* | Yellowtail hamlet | X | | X | | | |
| | *Hypoplectrus gummigutta* | Golden hamlet | | | | | | |
| | *Hypoplectrus guttavarius* | Shy hamlet | X | | | | | |
| | *Hypoplectrus indigo* | Indigo hamlet | X | | X | | X | |
| | *Hypoplectrus nigricans* | Black hamlet | X | | | | | |
| | *Hypoplectrus puella* | Barred hamlet | X | | X | | | |
| | *Hypoplectrus randallorum* | Tan hamlet | X | | | | | |
| Serranidae | *Hypoplectrus unicolor* | Butter hamlet | X | X | X | | | X |
| | *Hypoplectrus sp.* | Hamlets | | | X | | | |
| | *Hyporthodus niveatus* | Snowy grouper | | | | | | |
| | *Liopropoma carmabi* | Candy basslet | X | | | | | |
| | *Liopropoma mowbrayi* | Cave bass | | | | | | |
| | *Liopropoma rubre* | Peppermint bass | X | X | | | | |
| | *Mycteroperca acutirostris* | Comb grouper | | | | | | |
| | *Mycteroperca bonaci* | Black grouper | X | | | | X | |
| | *Mycteroperca interstitialis* | Yellowmouth grouper | | | | | | |
| | *Mycteroperca tigris* | Tiger grouper | X | X | | | | |
| | *Mycteroperca venenosa* | Yellowfin grouper | | X | | | | |
| | *Odontanthias hensleyi* | -- | | | | | | |
| | *Paranthias furcifer* | Creole-fish | X | X | | | | |
| | *Parasphyraenops incisus* | -- | | | | | | |
| | *Pseudogramma gregoryi* | Reef bass | | | | | | |
| | *Rypticus bistrispinus* | Freckled soapfish | | | | | | |
| | *Rypticus randalli* | -- | | | | | | |
| | *Rypticus saponaceus* | Greater soapfish | X | X | | | | |
| | *Rypticus subbifrenatus* | Spotted soapfish | | | | | | |
| | *Schultzea beta* | School bass | | | | | | |
| | *Serranus annularis* | Orangeback bass | | X | | | | |
| | *Serranus atrobranchus* | Blackear bass | | | | | | |
| | *Serranus baldwini* | Lantern bass | X | X | X | | | |
| | *Serranus chionaraia* | Snow bass | | | | | | |
| | *Serranus flaviventris* | Twinspot bass | X | | X | | | |
| | *Serranus luciopercanus* | Crosshatch bass | | | | | | |
| | *Serranus notospilus* | Saddle bass | | | | | | |

[9] Invasive species
[10] NMFS Species of Concern

<table>
<tr><th rowspan="2">Family</th><th rowspan="2">Species</th><th rowspan="2">Common Name</th><th colspan="2">Regional</th><th colspan="2">Local</th><th colspan="2">Site-Specific (Project Area)</th></tr>
<tr><th>reef.org [1]</th><th>EFH Species[2]</th><th>Jobos Bay NERR [3]</th><th>Aguirre Power Plant</th><th>Tt Dive Survey</th><th>Tt Ichthyo Survey</th></tr>
<tr><td rowspan="5"></td><td>Serranus phoebe</td><td>Tattler</td><td></td><td></td><td></td><td></td><td></td><td rowspan="5"></td></tr>
<tr><td>Serranus sp.</td><td>Basses</td><td></td><td></td><td>X</td><td></td><td></td></tr>
<tr><td>Serranus tabacarius</td><td>Tobaccofish</td><td>X</td><td>X</td><td>X</td><td></td><td></td></tr>
<tr><td>Serranus tigrinus</td><td>Harlequin bass</td><td>X</td><td>X</td><td>X</td><td></td><td>X</td></tr>
<tr><td>Serranus tortugarum</td><td>Chalk bass</td><td>X</td><td>X</td><td>X</td><td></td><td></td></tr>
<tr><td rowspan="6">Sparidae</td><td>Archosargus rhomboidalis</td><td>Western Atlantic seabream</td><td>X</td><td>X</td><td>X</td><td></td><td></td><td></td></tr>
<tr><td>Calamus bajonado</td><td>Jolthead porgy</td><td>X</td><td>X</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Calamus calamus</td><td>Saucereye porgy</td><td>X</td><td></td><td>X</td><td></td><td></td><td></td></tr>
<tr><td>Calamus penna</td><td>Sheepshead porgy</td><td>X</td><td>X</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Calamus pennatula</td><td>Pluma porgy</td><td>X</td><td>X</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Lagodon rhomboides</td><td>Pinfish</td><td></td><td></td><td></td><td>X</td><td></td><td></td></tr>
<tr><td rowspan="3">Sphyraenidae</td><td>Sphyraena barracuda</td><td>Great barracuda</td><td>X</td><td></td><td>X</td><td></td><td>X</td><td rowspan="3">X</td></tr>
<tr><td>Sphyraena guachancho</td><td>Guachanche barracuda</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Sphyraena picudilla</td><td>Southern sennet</td><td>X</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Sphyrnidae</td><td>Sphyrna lewini</td><td>Scalloped hammerhead[11]</td><td></td><td>X</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Synodontidae</td><td>Synodus intermedius</td><td>Sand diver</td><td>X</td><td>X</td><td>X</td><td></td><td>X</td><td></td></tr>
<tr><td rowspan="16">Syngnathidae</td><td>Amphelikturus dendriticus</td><td>Pipehorse</td><td></td><td></td><td></td><td rowspan="16">X</td><td></td><td rowspan="16">X</td></tr>
<tr><td>Anarchopterus tectus</td><td>Insular pipefish</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Bryx dunckeri</td><td>Pugnose pipefish</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Cosmocampus albirostris</td><td>Whitenose pipefish</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Cosmocampus brachycephalus</td><td>Crested pipefish</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Cosmocampus elucens</td><td>Shortfin pipefish</td><td>X</td><td></td><td></td><td></td></tr>
<tr><td>Hippocampus erectus</td><td>Lined seahorse</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Hippocampus reidi</td><td>Longsnout seahorse</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Hippocampus spp.</td><td>Seahorses</td><td></td><td>X</td><td></td><td></td></tr>
<tr><td>Micrognathus crinitus</td><td>Banded pipefish</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Microphis brachyurus</td><td>Short-tailed pipefish</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Microphis brachyurus lineatus</td><td>Opossum pipefish</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Syngnathus caribbaeus</td><td>Caribbean pipefish</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Syngnathus floridae</td><td>Dusky pipefish</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Syngnathus pelagicus</td><td>Sargassum pipefish</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Syngnathus spp.</td><td>Pipefishes</td><td></td><td>X</td><td></td><td></td></tr>
<tr><td rowspan="7">Tetraodontidae</td><td>Canthigaster rostrata</td><td>Caribbean sharpnose-puffer</td><td>X</td><td>X</td><td>X</td><td></td><td>X</td><td rowspan="7">X</td></tr>
<tr><td>Lagocephalus laevigatus</td><td>Smooth puffer</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Sphoeroides dorsalis</td><td>Marbled puffer</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Sphoeroides greeleyi</td><td>Green puffer</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Sphoeroides nephelus</td><td>Southern puffer</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Sphoeroides spengleri</td><td>Bandtail puffer</td><td>X</td><td></td><td>X</td><td></td><td></td></tr>
<tr><td>Sphoeroides testudineus</td><td>Checkered puffer</td><td></td><td></td><td>X</td><td></td><td>X</td></tr>
<tr><td rowspan="5">Tripterygiidae</td><td>Ennaenectes sp.</td><td>Triplefins</td><td>X</td><td></td><td></td><td></td><td></td><td rowspan="5">X</td></tr>
<tr><td>Enneanectes altivelis</td><td>Lofty triplefin</td><td>X</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Enneanectes boehlkei</td><td>Roughhead triplefin</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Enneanectes jordani</td><td>Mimic triplefin</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Enneanectes pectoralis</td><td>Redeye triplefin</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

[11] ESA Candidate Species

### *Protected Species*

Nine coral species occurring in the project area are listed (or candidates for listing) under the ESA. The only fish species with status under the ESA is the scalloped hammerhead shark (candidate species). However, as described in Section 4.3 for sharks in general, this species is a livebearer (no egg/larval stage in the water column) and is therefore not subject to entrainment. There are three fish species with protected status by PRDNR that occur in the project area.

#### Pelagic Coral Larvae

The larvae of ESA listed and candidate coral species described in the Benthic Characterization Report (Tetra Tech 2012) could be subject to entrainment during their spawning periods. However, the buoyant larvae present at the water surface in the days following spawning are not likely to become entrained by either the FSRU vessel or the LNGC vessel because the depth of water withdrawal is located in the mid-water column (7 m and 11 m below the surface) where coral larvae/planulae densities would be lowest. Characteristics and timing of spawning and larval stages of the nine ESA listed/candidate coral species are described in Table A-2.

**Table A-2: ESA Candidate/Listed Corals**

| Coral Species | Reproductive mode | Timing of reproduction (Peak times are listed but timing can vary by several days or be shifted by a month) | Time before larval are free-swimming |
|---|---|---|---|
| *Acropora cervicornis* | Spawn | 3 days after full Aug moon; 1900–2230 | 5–7 days |
| *Acropora palmata* | Spawn | 3–4 days after full Aug moon; around 2100 | 5–7 days |
| *Agaricia lamarcki* | Brood | Small-numbers released all night Sep–Oct | Immediate |
| *Dendrogyra cylindrus* | Spawn | Unknown | Unknown |
| *Dichocoenia stokesii* | Spawn | | |
| *Montastrea annularis f. annularis* | Spawn | 6–7 days after full Sep/Oct moon; around 2200 | 3–8 days |
| *Montastrea faveolata* | Spawn | 6–7 days after full Sep/Oct moon; around 2200 | 3–8 days |
| *Montastrea franksi* | Spawn | 6–7 days after full Sep/Oct moon; around 2200 | 3–8 days |
| *Mycetophyllia ferox* | Brood | | Immediate |

Sources: (Baird et al. 2009; Caribbean Marine Biological Institute 2011; Riddle 2008)

A sub-surface plankton tow may contain free-swimming larvae of many cnidarians including anemones, corals, and octocorals (larvae sizes range between 100–700 µm and are collected with appropriately sized nets nets). Under the microscope it is possible to distinguish anemone larvae from corals and octocorals, but it is difficult to distinguish corals from octocorals. It is extremely difficult to distinguish families or genera and next-to-impossible to distinguish species based on morphological characteristics of the larvae. Morphological identification is difficult with live specimens and is more difficult with preserved specimens. Genetic analyses are available to determine whether some species are present (i.e., *Acropora* spp. and *Porites astreoides*), but determining the identity or density of all ESA-listed/candidate species remains intractable with current technology.

No larval coral density data is available for the project area.

**Yellow Jack, *Carangoides bartholomaei***

The yellow jack occurs on offshore reefs, shallow sandy flats, and in the open waters over the continental shelf. It is typically found at depths ranging from 0-164 ft. (0-50 m). In nearshore waters, juveniles often occur in seagrass beds. Spawning occurs offshore from February through October, typically in aggregations that form just prior to sunrise. When the fertilized eggs hatch, the juveniles occupy the surface of the pelagic waters associated with large mats of sargassum, which provides sheltered protection from predators (Bester, 2012b). Yellow jack were not observed during the dive survey. However, larvae from the jack family (Carangidae) were observed during the ichthyoplankton survey.

**Goliath Grouper, *Epinephelus itajara***

The goliath grouper occurs over areas of rock, coral, and mud bottoms. It is typically found at depths up to 150 ft. (46 m). Juveniles typically occur in mangroves and brackish estuaries. Many groupers, including goliath groupers, are protogynous hermaphrodites—a reproductive strategy in which females later to become males. However, there are exceptions to this within certain populations. Spawning occurs from July until September and is strongly influenced by the lunar cycle. Spawning goliath grouper form offshore aggregations of up to 100 or more individuals. Their preferred spawning habitat is associated with underwater structure such as ship wrecks, rock ledges, and isolated patch reefs. After fertilization, eggs are pelagic and dispersed widely by currents. Juveniles settle in benthic habitats at lengths of 1 inch (2.5 cm), around 25 or 26 days after hatching (Robins 2012). Goliath grouper were not observed during the dive survey. However, larvae from the grouper family (Serranidae) were observed during the ichthyoplankton survey.

**Hognose Mullet, *Joturus pichardi***

Hognose mullet range throughout the Gulf of Mexico and the Caribbean. They occur in shallow waters ranging in depth from 1.6 to 11.5 ft. (0.5 to 3.5 m), and reach a maximum size of 26 inches (61 cm). They spawn in marine waters but are catadromous and move into freshwater as adults during periods of heavy rainfall. Adults then return to estuarine/marine waters to spawn. Spawning occurs in open water where eggs are pelagic and non-adhesive (Froese and Pauly 2012). Hognose mullet were not observed during the dive survey. However, larvae from the mullet family (Mugilidae) were observed during the ichthyoplankton survey.

### *Life History Information*

Certain life history and reproductive characteristics are important in determining a species' entrainment potential. Spawning season, egg size, spawning location, location in water column, and fecundity are all important factors to be considered. Table A-3 contains the available information for select EFH fish/shellfish species that may occur in the project area at various times of the year. This information, combined with site-specific ichthyoplankton densities obtained via sampling, determine the entrainment potential of these species.

**Table A-3: Life History and Egg Information for Selected EFH Species Occurring in the Project Area**

| Species | Common Name | Spawning Season | Egg Type | Egg Location in the Water Column | Egg Size (mm) | Spawning Habitat Characteristics | Additional Notes | Information Source(s) |
|---|---|---|---|---|---|---|---|---|
| *Acanthostracion quadricornis)* | Scrawled cowfish | Jul–Sep; Jan–Feb | buoyant, pelagic, spherical | pelagic; Open water/substratum egg scatterers | 1.46 mm | 27.3 C; associated with reefs and seagrass beds 10–80 m | development takes 2 days | (Froese and Pauly 2012) |
| *Acropora cervicornis* | Staghorn coral | Jul-Sep | buoyant | surface, rarely deeper than 30 m | 0.5–0.6 mm | Coral reef, > 27°C | 4–7 days after full moon in July–Sept, a few hours after sunset. May be in water column for 1–2 weeks after each spawning event, but 3–7 days is most common. | (Baird et al. 2009; Caribbean Marine Biological Institute 2011; Riddle 2008) |
| *Acropora palmata* | Elkhorn coral | Jul-Sep | buoyant | surface, rarely deeper than 30 m | 0.5–0.6 mm | Coral reef, > 27°C | 4–7 days after full moon in July–Sept, a few hours after sunset. May be in water column for 1–2 weeks after each spawning event, but 3–7 days is most common. | (Baird et al. 2009; Caribbean Marine Biological Institute 2011; Riddle 2008) |
| *Balistes vetula* | Queen triggerfish | year-round, peaking in fall and winter | demersal | bottom (in sandy nests) | | Nearshore, reef-associated, sandy bottom | eggs are deposited in sandy bowls; nests are aggressively guarded | (Froese and Pauly 2012) |
| *Carangoides bartholomaei* [12] | Yellow jack | Feb–Oct (esp. Jun–Aug) | pelagic | pelagic | | continental shelf depth range to 50 m | Forms aggregations of approximately 300 fishes with spawning occurring just before sunrise. When the fertilized pelagic eggs hatch, the juveniles live near the surface of the ocean amongst large mats of sargassum weed or jellyfish. | (Froese and Pauly 2012) |
| *Chaetodon striatus* | Banded butterflyfish | | pelagic | pelagic; open water/substratum egg scatterers | | reef-associated 3–55 m | Actual spawning takes place at dusk, with the female releasing anywhere from 3000 to 4000 eggs. Hatch within a day. Once they reach the size of a nickel, they settle on the bottom during the night. | (Froese and Pauly 2012) |
| *Epinephelus fulvus* (or *Cephalopholis fulva)* | Coney | Nov–Jul | spherical | pelagic; open water/substratum egg scatterers | 0.95 mm | reef-associated; prefers clear waters 2–150 m | spawning occurs just prior to sunset; each egg possesses a single oil globule | (Bester 2012a; Froese and Pauly 2012) |
| *Eucinostomus gula* [12] | Silver jenny | Apr–Aug | | | | Inhabits shallow waters, being especially abundant over mud bottoms in mangrove-lined lagoons or creeks; larger individuals may also occur on vegetated sand grounds in marine areas depths to 50 m. | | (Froese and Pauly 2012) |
| *Epinephelus guttatus* | Red hind | Dec, Jan, Feb | buoyant, pelagic, spherical | surface; open water/substratum egg scatterers | 0.96 mm | 26.5°C; species found in shallow reefs and rocky bottoms 2–100 m. | | (Froese and Pauly 2012) |
| *Epinephelus itajara* | Goliath grouper (jewfish) | Jul–Sep | pelagic | pelagic | | Ship wrecks, rock ledges, and isolated patch reefs depth range to 100 m | Upon hatching, the larvae are kite-shaped, with the second dorsal-fin spine and pelvic fin spines greatly elongated. These pelagic larvae transform into benthic juveniles at lengths of one inch (2.5 cm), around 25 or 26 days after hatching. | (Froese and Pauly 2012) |
| *Epinephelus striatus* | Nassau grouper | Dec, Jan, Feb | pelagic | pelagic; open water/substratum | | reef-associated; species occurs from the shoreline to at least 90 m depth. | Spawns near the new moon with up to 30,000 aggregating at certain spawning sites | (Froese and Pauly 2012) |

[12] EFH not designated for this species. Included here because this species is protected by PRDNR and was collected during entrainment studies at the Central Aguirre Power Plant.

| Species | Common Name | Spawning Season | Egg Type | Egg Location in the Water Column | Egg Size (mm) | Spawning Habitat Characteristics | Additional Notes | Information Source(s) |
|---|---|---|---|---|---|---|---|---|
| | | | | egg scatterers | | | | |
| *Farfantepenaeus duorarum* | Pink shrimp | April–Aug | | Pelagic | 0.33 mm | water column 12–52 ft., warmer months but over a wide range of temperatures 19–31°C | External fertilization, eggs hatch within minutes. Pelagic stages not longer than a few months. Postlarval settlement into estuaries often timed at new moons. | (Hill 2002) |
| *Haemulon plumieri* | White grunt | Aug–Sep (peak) | pelagic | pelagic | 0.9 mm | over hard bottoms or reefs 3–40 m | Hatching 20 hours after fertilization, larvae range from 2.7–2.8 mm in length | (Froese and Pauly 2012) |
| *Holocentrus ascensionis* | Squirrelfish | year-round | | open water/substratum egg scatterers | | over shallow coral reefs depths up to 30 m | | (Froese and Pauly 2012) |
| *Joturus pichardi* | Hognose mullet (bobo mullet) | | pelagic, non-adhesive | pelagic; open water/substratum egg scatterers | | brackish | | (Froese and Pauly 2012) |
| *Lagodon rhomboides*[13] | Pinfish | Oct–Mar | | | 1.02 mm | vegetated bottoms, occasionally over rocky bottoms and in mangrove areas 18 C | development takes 2 days | (Froese and Pauly 2012) |
| *Lutjanus analis* | Mutton snapper | Feb–Oct | pelagic | pelagic; open water/substratum egg scatterers | | Large adults usually among rocks; juveniles inshore over sandy or seagrass bottoms | At lengths of less than 10 mm, the larvae tend to be planktonic | (Froese and Pauly 2012) |
| *Lutjanus apodus* | Schoolmaster | Apr–Jun | | open water/substratum egg scatterers | | Occurs in shallow, clear, warm, coastal waters over coral reefs 2–63 m. | | (Froese and Pauly 2012) |
| *Lutjanus griseus* | Gray snapper | Jun–Oct, near full moon | demersal | bottom | < 4 mm | Found around coral reefs, mangroves, and rocky areas 5–180 m | Eggs hatch 20 hr post-fertilization; At lengths of less than 10 mm, the larvae tend to be planktonic; young found in lower reaches of rivers | (Froese and Pauly 2012) |
| *Lutjanus vivanus* | Silk snapper | year-round; highest in Jul–Sep | | open water/substratum egg scatterers | | reef-associated, near the edge of the continental and island shelves; depth range 90–242 m | | (Froese and Pauly 2012) |
| *Malacanthus plumieri* | Sand tilefish | | pelagic | mid-depth | < 2 mm | Nearshore, sand, rubble | | (Froese and Pauly 2012) |
| *Ocyurus chrysurus* | Yellowtail snapper | year-round | spherical, buoyant, pelagic | surface | < 3 mm | Adult yellowtail snappers live over sandy areas near deep reefs 10–70 m | The eggs hatch within 24 hours; they are planktonic at lengths less than 10mm. | (Froese and Pauly 2012) |
| *Panulirus argus* | Caribbean spiny lobster | year-round | buoyant larvae | fertilized eggs attached to female until they hatch ~4 weeks | 1 mm | hardbottom / rubble offshore of coral reefs | free-swimming late-stage larvae (pueruli) settle preferentially into clumps of the red algae *Laurencia* spp. where they metamorphose to juveniles and reside. for 2–3 months | (Caribbean Fishery Management Council 2004) |
| *Sparisoma chrysopterum* | Redtail parrotfish | | | open water/substratum egg scatterers | | reef-associated 1–15 m | | (Froese and Pauly 2012) |
| *Strombus gigas* | Queen conch | May—Sep | encased in long egg mass until hatching | | veligers range from 0.2 to 0.5 mm | shallow nearshore water, clean sand, >28°C | Eggs hatch ~72 hours after being deposited in egg-masses. free-swimming veliger is planktonic for ~18 days then shifts to swim/crawl stage as it seeks suitable habitat for settlement, typically seagrass. | (Puglisi 2008) |

# Appendix II:

# Quality Assurrance and Quality Control (QA/QC) Assessment of Ichthyopalnkton Taxonomic Identification and Enumeration Data

Departamento de Ciencias Marinas
Universidad de Puerto Rico
Recinto de Mayagüez

Department of Marine Sciences
University of Puerto Rico
Mayagüez Campus

To: Mr. John Schaffer, Mr. Brian Dresser, Ing. Fernando Pages
Tetra Tech, Inc.

From: Dr. Jorge R. Garcia Sais, Ph.D., University of Puerto Rico at Mayaguez

Date: April 19, 2013

**Subject: Quality Assurance and Quality Control (QA/QC) Analysis of Ichthyoplankton Samples Collected in May 2012 in Support of the Aguirre Gas Port Project**

The following memorandum details the QA/QC findings of the analysis and verification of ichthyoplankton samples collected from the off-shore waters from Jobos Bay in vicinity of the proposed Aguirre Gas Port Project as detailed in the Aguirre Offshore Gas Port Project Baseline Ichthyoplankton Characterization Plan (Tetra Tech, 2012). This memorandum will detail the following components:

Staffing Assignments and Qualifications
- Initial Identifications
- QA/QC Identifications

Taxonomic References Used in Initial and QA/QC Verification
Processing of Samples
Summary of Quality Assurance/Quality Control (QA/QC) Findings
References

**Staff Qualifications:**

*Sample Processing s*

Primary Fish/Invertebrate Egg and Larvae Sorting Specialist: Senora (Sra.) Ivonne Bejarano

Education and Qualifications:

- Candidate for Doctor of Philosophy (Ph. D) in Marine Sciences with specialization in ecology of mesophotic fish communities, University of Puerto Rico at Mayaguez
- Master of Science (MS) in Marine Science, University of Puerto Rico at Mayaguez with specialization in fisheries

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*Primary Ichthyoplankton Identification Specialist*

Primary Taxonomy and Enumeration: Dr. Aurea Santiago, Ph.D
Education and Qualifications:

- Ph. D. in Marine Sciences from the University of Puerto Rico at Mayaguez with specialization in mDNA molecular techniques for the identification of ichthyoplankton larvae (Lutjanidae) to species level differentiation.
- MS in Marine Science, University of Puerto Rico at Mayaguez with specialization in ichthyoplankton taxonomy and ecology

*Primary Invertebrate Identification Specialist*

Primary Invertebrate Identification Specialist: Sra. Julian Garcia
Education and Qualifications:

- Bachelor of Science (BS) candidate/student in the Biology Department at the University of Puerto Rico at Mayaguez (UPRM)
- Zooplankton Ecology course at the Department of Marine Sciences, UPRM
- Previous laboratory experience in identification and counts of invertebrate life stages and zooplankton for several coastal zooplankton projects in Caribbean waters.

*Quality Assurance (QA)/Quality Control (QC) Specialist*

QA/QC Taxonomy and Enumeration Specialist: Dr. Jorge R. Garcia Sais, Ph.D
Education and Qualifications:

- Ph. D. in Biological Oceanography from the University of Rhode Island at Kingston, R. I. with specialization in Biological Oceanography.
- MS in Marine Sciences from Department of Marine Science (DMS) University of Puerto Rico at Mayaguez (UPRM) with specialization in fish parasitology.
- Developed an ichthyoplankton taxonomy and ecology research program at DMS-UPRM that involved at least 12 research projects in Puerto Rico during the last 15 years.

**Taxonomic References Used in the Egg/Larval Identifications and QA/QC**:

The primary references used in the identification process included the following texts and references:


1) Richards, W. 2005. Early Stages of Atlantic Fishes: an identification guidse for the Western North Atlantic. Vols 1-2. Taylor and Francis Publishing, Boca Raton, FL.
2) Moser, H. G. (Ed in Chief) 1984. Ontogeny and systematics of Fishes. Allen Press, Lawrence, KS.
3) Leis, J. M. and B. M. Carson-Ewart. 2000. Fauna Malesiana: The Larvae of Indo-Pacific Coastal Fishes. Brill Press, Boston, MA.
4) Todd, C. D., M. S. Laverack & G. A. Boxshall. 1996. Coastal Marine Zooplankton: a practical manual for students. Cambridge University Press, Cambridge, UK.

5) W. J. Richards et al. 1994. Preliminary guide to the identifications of the early life history stages of Lutjanid fishes from the Western Central Atlantic. NOAA Tech. Memo. NMFS-SEFSC-345
6) Farooqi, T. R. F. Shaw and J. G. Ditty. 1995. Preliminary guide to the identifications of the early life history stages of anchovies (Engraulidae) from the Western Central Atlantic. NOAA Tech. Memo. NMFS-SEFSC-345
1) Victor, B. (website) Guide to the larval reef fishes of the Caribbean www.coralreeffish.com/larvae.html

**Summary of Quality Assurance/Quality Control (QA/QC) Findings**

The methods for the QA/QC evaluation followed those procedures outlined in the original scope of work (SOW) (Tetra Tech, 2012) and associated modifications based on sample splitting variation discussed during the conference call on November 28, 2012 between UPR and Tetra Tech personnel. Samples were re-analyzed following the QA/QC protocols outlined in the SOW (Tetr Tech, 2002) and associated modifications. The QA/QC process initially evaluated four (4) randomly selected samples as part of the initial comparison.

During the initial sample processing, sample analysis was complicated by the presence of an abundance of fine organic matter (FOM) concentrated by the plankton nets. The abundance of FOM was associated with plankton tow volumes in excess of 250 $m^3$. The enumeration process became problematic with the adhering of invertebrate eggs and larvae to the organic matter present, making their quantification very difficult and requiring further splitting of the samples in some cases by the QA/QC examiner.

In response to this influence and consistent with the SOW, a second and third set of four samples were reprocessed. This continued influence of the excess organic matter required the re-evaluation using a greater frequency in splitting of the samples. Additionally, an adjustment of the percent error threshold for invertebrate eggs and larvae was recommended to be raised to 15% to allow for the uncertainty in the differences better quantification and comparison between the initial and QA/QC evaluations given the splitting frequencies required. Table 1 presents the comparison between the initial and the QA/QC evaluations.

Variations in enumeration criteria of ±10% were not met after the second set of 4 samples (8 total) for total invertebrate counts. The main source of error was likely associated with the sample splitting process which always carries an intrinsic source of error in every split for those taxa found in very low abundance.

The mean coefficients of variation for the taxonomic and count categories were:

Fish larvae taxonomic identifications: 3.85 %
Total fish larvae counts: 7.46 %
Total fish eggs counts: 9.23 %
Total invertebrate counts: 11.71 %

The identification and enumeration categories were all below the ±10 % coefficient of variation, and 4 consecutive samples within the 10 % agreement were achieved by the second set of 4 for all fish egg and larvae groups. Variations above the initially set criteria of 10% were not met after the second set of 4 samples (8 total) for total invertebrate counts. A third set of 4 were re-examined to continue the QA/QC evaluation process. To address variation observed in the splitting of samples for invertebrate eggs and larvae a 15% threshold was qualitatively considered for invertebrate eggs and larvae (with the exception of crab and lobster larvae) to address the associated variation in splitting frequency. This corrected threshold was met by the third set of samples and by final QA/QC sample evaluated in the analysis. The results of the QA/QC findings will be incorporated in to Draft Entrainment Characterization Report.

## References

Tetra Tech, Inc. 2012. Aguirre Offshore Gasport Project: Baseline Ichthyoplankton Characterization Plan and Thermal Plume Modeling. Prepared for Excelerate Energy LP, The Woodlands, TX.

Table 1. Comparison Summary of Original Sample identification and Enumeration with QA/QC Evaluation - May 2012 Samples

| Samples | Fish Taxa Initial Report | QA/QC | mean | stdev | coef. var. | Percent Error |
|---|---|---|---|---|---|---|
| T1BD | 14 | 15 | 14.5 | 0.707 | 4.88 | -7.1 |
| T1BN | 20 | 18 | 19 | 1.414 | 7.44 | 10.0 |
| T3AN | 14 | 13 | 13.5 | 0.707 | 5.24 | 7.1 |
| T3BD | 18 | 17 | 17.5 | 0.707 | 4.04 | 5.6 |
| T4AD | 11 | 11 | 11 | 0.000 | 0.00 | 0.0 |
| T4BD | 12 | 11 | 11.5 | 0.707 | 6.15 | 8.3 |
| T2BN | 19 | 18 | 18.5 | 0.707 | 3.82 | 5.3 |
| T2BD | 16 | 15 | 15.5 | 0.707 | 4.56 | 6.3 |
| T2AD | 12 | 12 | 12 | 0.000 | 0.00 | 0.0 |
| T3BN | 18 | 17 | 17.5 | 0.707 | 4.04 | 5.6 |
| T3AD | 10 | 10 | 10 | 0.000 | 0.00 | 0.0 |
| T2AN | 13 | 12 | 12.5 | 0.707 | 5.66 | 7.7 |
| T1AN | 17 | 16 | 16.5 | 0.707 | 4.29 | 5.9 |
| Means | 14.9 | 14.2 | 14.6 | 0.598 | 3.85 | 4.19 |
| Stdev. | 3.28 | 2.86 | 3.05 | 0.392 | | |
| Coef. Var. | 22.0 | 20.1 | 21.0 | | | |

| Samples | Total Fish Larvae Initial Report | QA/QC | mean | stdev | coef var | Percent Error |
|---|---|---|---|---|---|---|
| T1BD | 210 | 153 | 181.5 | 40.305 | 22.21 | -37.3 |
| T1BN | 246 | 227 | 236.5 | 13.435 | 5.68 | -8.4 |
| T3AN | 386 | 342 | 364 | 31.113 | 8.55 | -12.9 |
| T3BD | 130 | 132 | 131 | 1.414 | 1.08 | 1.5 |
| T4AD | 220 | 189 | 204.5 | 21.920 | 10.72 | -16.4 |
| T4BD | 203 | 190 | 196.5 | 9.192 | 4.68 | -6.8 |
| T2BN | 291 | 327 | 309 | 25.456 | 8.24 | 11.0 |
| T2BD | 155 | 142 | 148.5 | 9.192 | 6.19 | -9.2 |
| T2AD | 168 | 154 | 161 | 9.899 | 6.15 | -9.1 |
| T3BN | 283 | 269 | 276 | 9.899 | 3.59 | -5.2 |
| T3AD | 130 | 119 | 124.5 | 7.778 | 6.25 | -9.2 |
| T2AN | 457 | 413 | 435 | 31.113 | 7.15 | -10.7 |
| T1AN | 413 | 377 | 395 | 25.456 | 6.44 | -9.5 |
| Means | 253 | 233 | 243 | 18.2 | 7.46 | -9.39 |
| Stdev. | 107.9 | 101.3 | 104.0 | 11.7 | | |
| Coef. Var. | 42.6 | 43.4 | 42.7 | | | |

| Samples | Total Fish Eggs Initial Report | QA/QC | mean | stdev | coef var | Percent Error |
|---|---|---|---|---|---|---|
| T1BD | 1764 | 1580 | 1672 | 130.11 | 7.78 | -11.6 |
| T1BN | 1129 | 836 | 982.5 | 207.18 | 21.09 | -35.0 |
| T3AN | 1149 | 800 | 974.5 | 246.78 | 25.32 | -43.6 |
| T3BD | 1949 | 1920 | 1934.5 | 20.51 | 1.06 | -1.5 |
| T4AD | 1143 | 1320 | 1231.5 | 125.16 | 10.16 | 13.4 |
| T4BD | 1054 | 1120 | 1087 | 46.67 | 4.29 | 5.9 |
| T2BN | 992 | 1240 | 1116 | 175.36 | 15.71 | 20.0 |
| T2BD | 1562 | 1400 | 1481 | 114.55 | 7.73 | -11.6 |
| T2AD | 1543 | 1400 | 1471.5 | 101.12 | 6.87 | -10.2 |
| T3BN | 904 | 1000 | 952 | 67.88 | 7.13 | 9.6 |
| T3AD | 1659 | 1880 | 1769.5 | 156.27 | 8.83 | 11.8 |
| T2AN | 1175 | 1240 | 1207.5 | 45.96 | 3.81 | 5.2 |
| T1AN | 962 | 960 | 961 | 1.41 | 0.15 | -0.2 |
| Means | 1307 | 1284 | 1295 | 110.7 | 9.23 | -3.69 |
| Stdev. | 343 | 357 | 336 | 73.6 | | |
| Coef. Var. | 26.2 | 27.8 | 26.0 | | | |

| Samples | Total Decapod/Mollusk larvae Initial Report | QA/QC | mean | stdev | coef var | Percent Error |
|---|---|---|---|---|---|---|
| T1BD | 5376 | 5208 | 5292 | 118.79 | 2.24 | -3.2 |
| T1BN | 3703 | 5933 | 4818 | 1576.85 | 32.73 | 37.6 |
| T3AN | 3296 | 6040 | 4668 | 1940.30 | 41.57 | 45.4 |
| T3BD | 4800 | 4108 | 4454 | 489.32 | 10.99 | -16.8 |
| T4AD | 2352 | 2604 | 2478 | 178.19 | 7.19 | 9.7 |
| T4BD | 3506 | 3372 | 3439 | 94.75 | 2.76 | -4.0 |
| T2BN | 7272 | 7740 | 7506 | 330.93 | 4.41 | 6.0 |
| T2BD | 4962 | 4444 | 4703 | 366.28 | 7.79 | -11.7 |
| T2AD | 3740 | 3504 | 3622 | 166.88 | 4.61 | -6.7 |
| T3BN | 4164 | 4856 | 4510 | 489.32 | 10.85 | 14.3 |
| T3AD | 2480 | 2888 | 2684 | 288.50 | 10.75 | 14.1 |
| T2AN | 6290 | 6776 | 6533 | 343.65 | 5.26 | 7.2 |
| T1AN | 5105 | 5973 | 5539 | 613.77 | 11.08 | 14.5 |
| Means | 4388 | 4880 | 4634 | 538 | 11.7 | 8.18 |
| Stdev. | 1432 | 1571 | 1417 | 568 | | |
| Coef. Var. | 32.6 | 32.2 | 30.6 | | | |

# Attachment I

## QA/QC Benchsheet Summaries
## May 2012 Ichthyoplankton Survey

Table A1. Quality Assurance/Quality Control analysis of zooplankton/ichthyoplankton samples from Jobos Bay, Tetra Tech Gasport Studies.

| Sampling Stations | T1B-D | QA/QC T1B-D | T1B-N | QA/QC T1B-N | T3A-N | QA/QC T3A-N | T3B-D | QA/QC T3B-D |
|---|---|---|---|---|---|---|---|---|
| **Fish Larvae Taxa** | (Values are No. Individuals per Sample) | | | | | | | |
| Antennaridae | | | | | | | | 1 |
| Atherinidae | | | | | | | 1 | |
| Callionymidae | | | 2 | 2 | | | | |
| Carangidae | 2 | 1 | 2 | 2 | 7 | 2 | 1 | 1 |
| Clupeidae | 2 | | 54 | | 51 | | 12 | |
| Clupeiformes | 79 | 49 | 44 | 132 | 188 | 246 | 35 | 54 |
| Engraulidae | | | 2 | | 3 | 1 | | |
| Ephippidae | | | 1 | 1 | | | | |
| Exocoetidae | | | 1 | 2 | | | | |
| Gerreidae | 1 | 3 | | | 3 | 2 | 2 | 1 |
| Gobiesocidae | 2 | 1 | 5 | 3 | | | | |
| Gobiidae | 13 | 3 | 17 | 4 | 11 | 8 | 10 | 6 |
| Haemulidae | 17 | 3 | 25 | 9 | 20 | 11 | 2 | 2 |
| Labridae | 5 | 1 | 2 | 3 | 3 | 2 | 6 | 2 |
| Lutjanidae | | 3 | 12 | 12 | 11 | 9 | 1 | 2 |
| Microdesmidae | | 1 | 1 | 1 | | | 2 | 1 |
| Ophichthidae | | | | | | | 1 | 1 |
| Pomacanthidae | | | | | 18 | | | |
| Pomacentridae | 9 | 3 | 16 | 5 | 1 | 9 | 20 | 5 |
| Scaridae | 2 | 2 | 2 | 1 | | | | |
| Scombridae | 2 | 2 | | | 1 | 1 | 1 | 1 |
| Serranidae | | | 1 | | | | 1 | |
| Sphyraenidae | 4 | 2 | 2 | 2 | 1 | 1 | 7 | 3 |
| Syngnathidae | 13 | 14 | 11 | 11 | 4 | 2 | 1 | 1 |
| Tetraodontidae | | | 1 | 1 | | | 1 | |
| Tripterygiidae | 1 | 1 | 5 | 3 | | | 1 | 1 |
| Unidentified | 58 | 64 | 40 | 33 | 64 | 48 | 25 | 50 |
| **Total Fish Larvae** | 210 | 153 | 246 | 227 | 386 | 342 | 130 | 132 |
| **# taxa** | 14 | 15 | 20 | 18 | 14 | 13 | 18 | 17 |
| **Total Fish Eggs** | 1,764 | 1,580 | 1,129 | 836 | 1,149 | 800 | 1,949 | 1,920 |
| **Decapod/Mollusk Larvae** | | | | | | | | |
| Phylum Arthropoda, Class Crustacea, Order Decapoda | | | | | | | | |
| Section Anomura | 4 | 4 | | | | | 12 | 12 |
| Section Brachyura | 680 | 1,040 | 412 | 720 | 364 | 520 | 392 | 640 |
| Sub-Order Natantia | 4,100 | 3,400 | 3098 | 4840 | 2724 | 5280 | 4216 | 3040 |
| Sub-Order Panilura | | | 1 | 1 | | | | |
| Phylum Mollusca | | | | | | | | |
| Class Gastropoda | 588 | 760 | 168 | 360 | 208 | 240 | 164 | 400 |
| Class Cephalopoda, | | | | | | | | |
| Order Teuthoidea | 4 | 4 | 24 | 12 | | | 16 | 16 |
| **Total Invertebrates** | 5376 | 5208 | 3703 | 5933 | 3296 | 6040 | 4800 | 4108 |

Table A2. Quality Assurance/Quality Control analysis of zooplankton/ichthyoplankton samples from Jobos Bay, Aguirre Gasport Studies. Samples 5 through 8.

| Sampling Stations | T4A-D | QA/QC T4A-D | T4B-D | QA/QC T4B-D | T2B-N | QA/QC T2B-N | T2B-D | QA/QC T2B-D |
|---|---|---|---|---|---|---|---|---|
| **Fish Larvae Taxa** | (Values are No. of Individuals per Sample) | | | | | | | |
| Apogonidae | | | 1 | 1 | | | | |
| Atherinidae | | | | | 1 | 1 | 1 | 1 |
| Bythitidae | | | | | | | 1 | 1 |
| Callionymidae | | | | | 1 | 1 | | |
| Carangidae | 3 | | 3 | 1 | 2 | 2 | 4 | 1 |
| Clupeidae | 5 | | 1 | | 61 | | 8 | |
| Clupeiformes | 82 | 81 | 79 | 78 | 51 | 122 | 38 | 42 |
| Engraulidae | 6 | | 6 | | 9 | | | |
| Exocoetidae | | | | | 2 | 1 | | |
| Gerreidae | 2 | 2 | 11 | 4 | 4 | 2 | 3 | 1 |
| Gobiesocidae | | 3 | | | 3 | 2 | | |
| Gobiidae | 14 | 6 | 11 | 8 | 17 | 6 | 15 | 9 |
| Haemulidae | 17 | 3 | 7 | 6 | 51 | 31 | 8 | 8 |
| Labridae | 2 | 1 | 6 | 2 | 2 | 1 | 8 | 1 |
| Lutjanidae | 3 | 3 | | | 10 | 10 | 3 | 4 |
| Microdesmidae | | | 1 | 1 | | | | |
| Monacanthidae | | | | | | | 1 | 1 |
| Mugilidae | | | 1 | | | | | |
| Opistognathidae | | | | | 1 | 1 | 3 | 3 |
| Pomacentridae | 30 | 24 | 16 | 13 | 13 | 18 | 12 | 7 |
| Scaridae | | | | | 4 | 3 | | |
| Sciaenidae | | | | | 4 | 1 | | |
| Scombridae | | | | | 1 | 1 | 1 | 1 |
| Sphyraenidae | 2 | 1 | 4 | 1 | 1 | | 2 | |
| Syngnathidae | 7 | 7 | 1 | 1 | 7 | 6 | 7 | 7 |
| Tripterygiidae | 1 | 4 | | | 13 | 3 | 2 | 3 |
| Unidentified | 46 | 54 | 55 | 74 | 33 | 115 | 38 | 52 |
| **Total Fish Larvae** | 220 | 189 | 203 | 190 | 291 | 327 | 155 | 142 |
| **No. Taxa** | 11 | 11 | 12 | 11 | 19 | 18 | 16 | 15 |
| **Total Fish Eggs** | 1,143 | 1,320 | 1,054 | 1,120 | 992 | 1,240 | 1,562 | 1,400 |
| **Decapod/Mollusk Larvae** | | | | | | | | |
| Phylum Arthropoda, Class Crustacea, Order Decapoda | | | | | | | | |
| Section Anomura | | | 8 | 4 | 12 | 8 | 20 | 16 |
| Section Brachyura | 212 | 440 | 432 | 560 | 1000 | 1240 | 600 | 688 |
| Sub-Order Natantia | 2,048 | 1,960 | 2874 | 2200 | 6000 | 5840 | 3964 | 3200 |
| Sub-Order Panilura | | | | | | | | |
| Phylum Mollusca | | | | | | | | |
| Class Gastropoda | 84 | 200 | 176 | 600 | 248 | 640 | 350 | 520 |
| Class Cephalopoda, | | | | | | | | |
| Order Teuthoidea | 8 | 4 | 16 | 8 | 12 | 12 | 28 | 20 |
| **Total Invertebrates** | 2352 | 2604 | 3506 | 3372 | 7272 | 7740 | 4962 | 4444 |

Table A3. Quality Assurance/Quality Control Analysis of Zooplankton/Ichthyoplankton Samples from Jobos Bay, Aguirre Gasport Studies. QA/QC Samples 9 through 12.

| | | QA/QC | | QA/QC | | QA/QC | | QA/QC |
|---|---|---|---|---|---|---|---|---|
| **Sampling Stations** | **T2A-D** | **T2A-D** | **T3B-N** | **T3B-N** | **T3A-D** | **T3A-D** | **T2A-N** | **T2A-N** |
| **Fish Larvae Taxa** | **(Values are No. Individuals per Sample)** | | | | | | | |
| Antennaridae | | | | | 2 | 2 | | |
| Callionymidae | | | | | | | 1 | 1 |
| Carangidae | 2 | 3 | 3 | 2 | | | 4 | 3 |
| Clupeidae | 7 | | 45 | | 3 | | 55 | |
| Clupeiformes | 46 | 53 | 116 | 151 | 59 | 59 | 225 | 256 |
| Coryphaenidae | | | | | | 1 | | |
| Eleotridae | | | 1 | | | | | |
| Engraulidae | 3 | | 2 | | 1 | | 11 | |
| Gerreidae | 1 | 1 | | | | | | |
| Gobiesocidae | 2 | 2 | 2 | 2 | | | | |
| Gobiidae | 3 | 3 | 17 | 12 | 1 | 1 | 26 | 15 |
| Haemulidae | 14 | 9 | 26 | 14 | 5 | 3 | 17 | 14 |
| Hemiramphidae | 2 | 1 | 3 | 4 | 1 | 1 | | |
| Labridae | | | 5 | 4 | | | 4 | 2 |
| Lutjanidae | 2 | 3 | 4 | 4 | 1 | 3 | 8 | 8 |
| Nemichthydae | | | 1 | 1 | | | | |
| Ophichthidae | | | | | 1 | 1 | | |
| Pomacentridae | 16 | 16 | 10 | 8 | 8 | 3 | 20 | 23 |
| Pomacanthidae | | | | | | | 3 | |
| Scaridae | | | 4 | 3 | | | | |
| Scombridae | | | 1 | 1 | | | 1 | 1 |
| Serranidae | 1 | 1 | 1 | 1 | | | 1 | 1 |
| Sphyraenidae | | | 2 | 1 | 3 | 1 | 2 | 1 |
| Syngnathidae | 8 | 8 | 4 | 4 | 7 | 7 | 4 | 4 |
| Tetraodontidae | | | 1 | 1 | | | | |
| Tripterygiidae | 7 | 6 | 1 | 1 | | | | |
| Unidentified | 54 | 48 | 34 | 55 | 38 | 37 | 75 | 84 |
| **Total Fish Larvae** | 168 | 154 | 283 | 269 | 130 | 119 | 457 | 413 |
| **# taxa** | 12 | 12 | 18 | 17 | 10 | 10 | 13 | 12 |
| **Total Fish Eggs** | 1,543 | 1,400 | 904 | 1,000 | 1,659 | 1,880 | 1,175 | 1,240 |
| **Decapod/Mollusk Larvae** | | | | | | | | |
| Phylum Arthropoda, Class Crustacea, Order Decapoda | | | | | | | | |
| Section Anomura | 8 | 8 | | | 4 | 4 | 8 | 4 |
| Section Brachyura | 372 | 400 | 480 | 680 | 676 | 720 | 228 | 680 |
| Sub-Order Natantia | 2,700 | 2,640 | 3432 | 3720 | 1620 | 1880 | 5950 | 5800 |
| Sub-Order Panilura | 4 | 4 | | | | | 8 | 8 |
| Phylum Mollusca | | | | | | | | |
| Class Gastropoda | 640 | 440 | 232 | 440 | 172 | 280 | 92 | 280 |
| Class Cephalopoda | | | | | | | | |
| Order Teuthoidea | 16 | 12 | 20 | 16 | 8 | 4 | 4 | 4 |
| **Total Invertebrates** | 3740 | 3504 | 4164 | 4856 | 2480 | 2888 | 6290 | 6776 |